FLIGHT

The AIRCRAFT ENGINEER & AIRSHIPS

First Aero Weekly in the World

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice, and Progress of Aerial Locomotion and Transport

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CONTENTS

DIARY OF FORTHCOMING EVENTS

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in the following list:—

1926

May 30	**Gordon-Bennett Balloon Race, Antwerp.**
June 11	**Independent Force (R.A.F.) Dinner Club Annual Re-union Dinner, Connaught Rooms, Great Queen Street, Kingsway.**
June 11–13	**Belgian Light 'Plane and Touring Aeroplane Competition.**
June 12	**Inst. Ae.E. visit to Croydon Aerodrome.**
July 8–24	**Royal Tournament, Olympia**
July 9–10	**King's Cup Race, Hendon.**
July 11–27	**German Seaplane Competition at Warnemunde.**
Aug. 9-15	**French Light 'Plane Competition.**
Sept. 10-17	**Two-Seater Light Aeroplane Competition, Lympne.**
Sept. 18	**Grosvenor Challenge Cup, at Lympne.**
Oct.	**Schneider Cup Race at Norfolk, Virginia, U.S.A.**
Nov.–Dec.	**Paris Aero Show.**

EDITORIAL COMMENT.

ALTHOUGH the aircraft industry, like every other industry in the country, was affected by the general strike, it would appear that in the majority of cases work was maintained for the greater part of the duration of the strike, although naturally at somewhat reduced speed, and if the constructional side has suffered to some extent, as is almost inevitable, the operational side may be said more than to have made up for this morally by the increased activity which the stoppage of all regular transport called into being, and so on the whole, perhaps, it can be accepted that the strike did quite a lot of good, so far as aviation is concerned. A very good picture of aviation in the strike period was given by Commander Perrin in last week's issue of FLIGHT, in which the secretary of the Royal Aero Club set out an account of the work done by that section of the emergency air services of which he was in charge. This week, in the Official Notices of the Royal Aero Club, published on page 310, some statistics are found which help to throw further light on the extent to which civil aeroplanes of all sorts came to the assistance of the country during a very trying period. Before commenting on the story which these statistics tell, we would call attention to some remarks in Commander Perrin's article in our May 20 issue.

Some Statistics

On page 297, the third paragraph from the top in the left-hand column stated that: "Our experiences emphasise, incidentally, the need for a more adequate official gazetteer, or some such volume, dealing not only with main aerodromes and alighting-points but also with landing facilities all over the country on a much wider and more comprehensive scale. Our pilots in these recent flights could provide much practical information, and what is needed is a new committee to go into this question forthwith. The development of popular flying makes it one of urgent importance."

It may be recollected that during the last Royal Aero Club Monthly House Dinner, Mr. Alan Cobham

pointed out that what the country needed more than anything else at the moment in order to encourage private flying was an aerodrome at every town and every village in the United Kingdom. When aerodrome facilities were to be found almost anywhere, it would be possible to use aeroplanes for touring and other private use. Until such facilities existed there was some difficulty in making full use of the advantages which the aeroplane had to offer. Commander Perrin's remarks seem to indicate that he has arrived at very much the same conclusion, and he recommends the formation of a committee to look into the subject, not perhaps so much the establishment of new aerodromes and landing grounds as a careful survey and tabulation of existing ones suitable for privately-owned aeroplanes.

It will, of course, be common knowledge that there is already in existence a publication which deals with the larger aerodromes and landing grounds both at home and abroad, under the title *The Air Pilot*, monthly supplements to which are issued. This work, published by order of the Air Council, and sold by H.M. Stationery Office, deals, however, mainly with air stations under the control of the Air Ministry, *i.e.*, service stations, and with existing licensed civil aerodromes. Before the ideal advocated by Mr. Cobham can be realised, it will, of course, be necessary to locate a vastly larger number of landing "fields" suitable for use by civilian machines, and although the Air Ministry cannot well be expected to undertake this work in its entirety, the task is of such a magnitude that Air Ministry assistance is almost essential. The Royal Aero Club, and the light 'plane clubs, can do a great deal of useful work, and one of the first lines of attack on the problem would seem to be an appeal to all the large cities of the Kingdom to help by at any rate not placing obstacles in the way of the establishment of suitable landing grounds in their vicinity. It is quite obvious that it would be to the advantage of all British towns to have their own aerodrome facilities, but the problem of convincing them of these advantages is not likely to be one easy of attainment. The existing light 'plane clubs could probably do a great deal of good in this direction, and could also make a very good start by carrying out aerial surveys along the routes joining the different club aerodromes. If fields suitable for forced landings could be located at fairly close intervals along these routes, visits by the aeroplanes of one light 'plane club to the aerodrome of another light 'plane club would be greatly facilitated, and the paying of "calls" by air would no doubt help materially in awakening a much wider interest in the subject of flying. Incidentally, club members would derive a great deal of pleasure, not to mention the value of the experience, from the carrying out of such surveys, which experience would stand them in good stead later when taking part in cross-country races such as will certainly take place during the years to come. To the Royal Aero Club would naturally fall the task of receiving and collating the information gathered by the light 'plane clubs, and to make arrangements with the owners of such landing grounds for permission to use them. The task will be a very large one, but with goodwill on all sides it should be possible to make a useful start almost immediately.

Turning now to the statistics published in the Royal Aero Club's Official Notices this week, it is seen that civilian machines, not including those of Imperial Airways, covered during the strike no less than 44,733 miles, of which 33,174 miles were flown by the emergency services organised and conducted by the Royal Aero Club. Out of these totals, the de Havilland "Moths" appear to have accounted for something like 15,445 miles. As far as shown by the Royal Aero Club statistics, eight "Moths" were in service, so that the average mileage of each was approximately 1930 miles, a record of which both makers and owners of these machines may well be proud.

The honour of having put up the greatest mileage, in the "Moth" class, goes to G-EBMF, of the London Aeroplane Club, to whose credit stands a mileage of no less than 3,384. If further proof were needed of the capacity for hard work possessed by the de Havilland "Moth" and its "Cirrus" engine, it is provided by these figures, which we have no doubt will come as something of an eye-opener to many who had looked upon them as "toys." The light 'plane clubs themselves have probably been surprised, in spite of the record of good service which the "Moths" have established in ordinary club work, and altogether the service given by these little machines calls forth the most unreserved admiration.

Of individual performances by machines of higher power, it would seem that that of Col. Henderson on a D.H.9 with Siddeley "Puma" engine stands well above the average, with a total mileage (and the same pilot throughout) of 5,046 miles. Taking the average speed of the machine as 100 m.p.h., this appears to indicate that Col. Henderson did something like 50 hours' actual flying during the strike, no mean performance when the nature of the flying is taken into consideration.

It is impossible to refer to and comment upon in detail all the splendid air work done during the strike, but one interesting fact emerges from a perusal of the statistics ; No less than three machines whose identification letters commence with G-EA took part in the emergency services. These letters indicate that the machines must be fairly ancient, the oldest being one belonging to the Southern Counties Aviation Co., and which carried the identification letters G-EAAY. All three machines were Avros, and the oldest of the lot, G-EAAY, managed to get in 540 miles, which is not bad for a veteran. One knows, of course, that the Avro 504 *as a type* is immortal, but this shows the longevity of individual machines. For the benefit of those not familiar with the system of identification letters, we may explain that when the system first came into use, the first British civil machine was given the identification letters G-EAAA, the next G-EAAB, and so forth until G-EAAZ had been reached, when the next machine received the letters G-EABA. Thus the identification letters are a fairly good index to the age of a machine.

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TO OUR READERS.

With the present issue of "Flight," which, we are afraid, will reach our readers some 24 hours' late, we once more approach normal publication after the delays inevitably caused by the late General Strike. Next week's issue will go to press at the usual time, and will be distributed in the normal manner.

THE BLACKBURN "SPRAT"

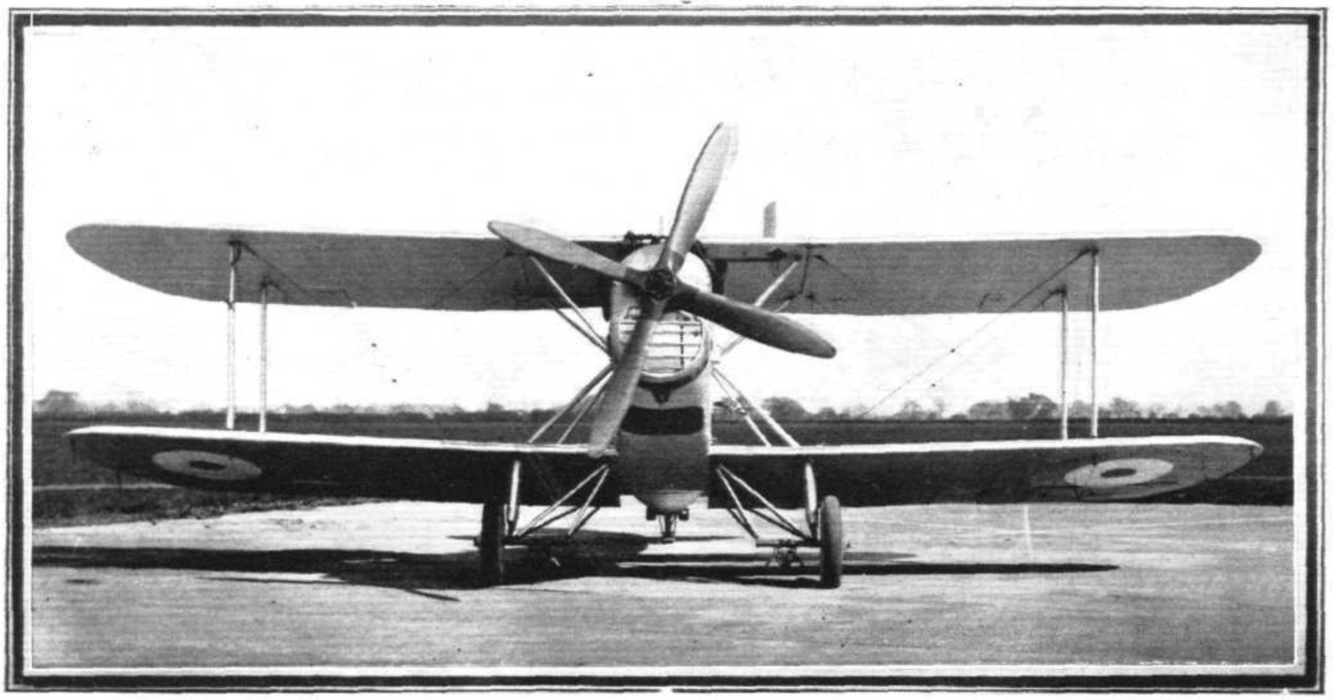
A Training Machine Convertible into Landplane or Seaplane

IN external appearance, no less than in detail construction, the Blackburn "Sprat" bears a very strong "family resemblance" to the famous Blackburn "Swift" and "Dart" machines, which are already familiar to our readers. The "Sprat" has, however, been designed for use as a training machine, and consequently a power unit of considerably lower power is fitted. The engine fitted as standard is the Rolls-Royce "Falcon," of 275 h.p., although the makers point out that if desired, the machine can easily be adapted for other engines of approximately the same power. As illustrated in the accompanying photographs and general arrangement drawings, the "Sprat" is shown with the "Falcon."

In general design the Blackburn "Sprat" is of the normal biplane type, with top and bottom wings of equal span. A feature of the design is that the machine can be changed rapidly from a landplane to a seaplane and *vice versa*, the two types of undercarriage being so designed that each is a complete unit in itself, detachable at the fuselage and wing root joints. As a seaplane the "Sprat" is of the twin-float type, the float undercarriage being so designed that no cross tubes or struts are required. As a landplane the "Sprat" has an undercarriage similar in design to that of the well-known "Swift." In the general arrangement drawings the machine is shown with the land undercarriage drawn in full lines and the float chassis in dotted lines.

Controllability in the air and on the water, low landing speed, good view from both cockpits, and economy in operation and maintenance were the objects aimed at in the design of the Blackburn "Sprat." Concerning the manœuvrability and general behaviour on the water, the form and dimensions of the floats are based upon those fitted to the Blackburn "Dart," which has been in use for a long time at the Blackburn training school at Brough. These floats have been tested in the tank in model form, and it was found that they ran very cleanly, had no tendency to "porpoising," and led to stable conditions when trimmed to take off. Full scale tests have confirmed these results. The "Dart" seaplane takes off with the pilot's hands off all controls. In order to facilitate manœuvring at low speeds, the floats are fitted with water rudders. While on the subject of floats, it should be pointed out that the "Sprat" can be supplied with either wood floats or all-Duralumin floats. One of our sketches shows the metal floats, with some of their constructional details. It will be seen that the floats are of the vee-bottom rounded deck type with single steps, and the keelson extends from the keel to the deck, the chassis struts being attached to the keelson and bedding down on the keel. These sketches also indicate the attachments on the floats for wheeled trestles used in changing one type of undercarriage for the other, and as there are no cross tubes or axles in either undercarriage, each half of either can be detached or attached independently of the other half, which naturally facilitates the operation.

Constructionally the "Sprat" follows the "Swift" and "Dart" types, the fuselage being built up in such a manner that components are grouped in units easy of access and removal with a minimum of disturbance of the main structure. There are three such units, the engine unit, the central unit or backbone (which is built entirely of steel tubing) to which all the main components are attached, and the tail portion, which is of wood construction. The engine unit is quickly detachable by means of four bolts, just forward of the fireproof bulkhead, and is so designed that when disconnected from the fuselage it forms its own engine bed and can be set down on a flat bench or on the floor.



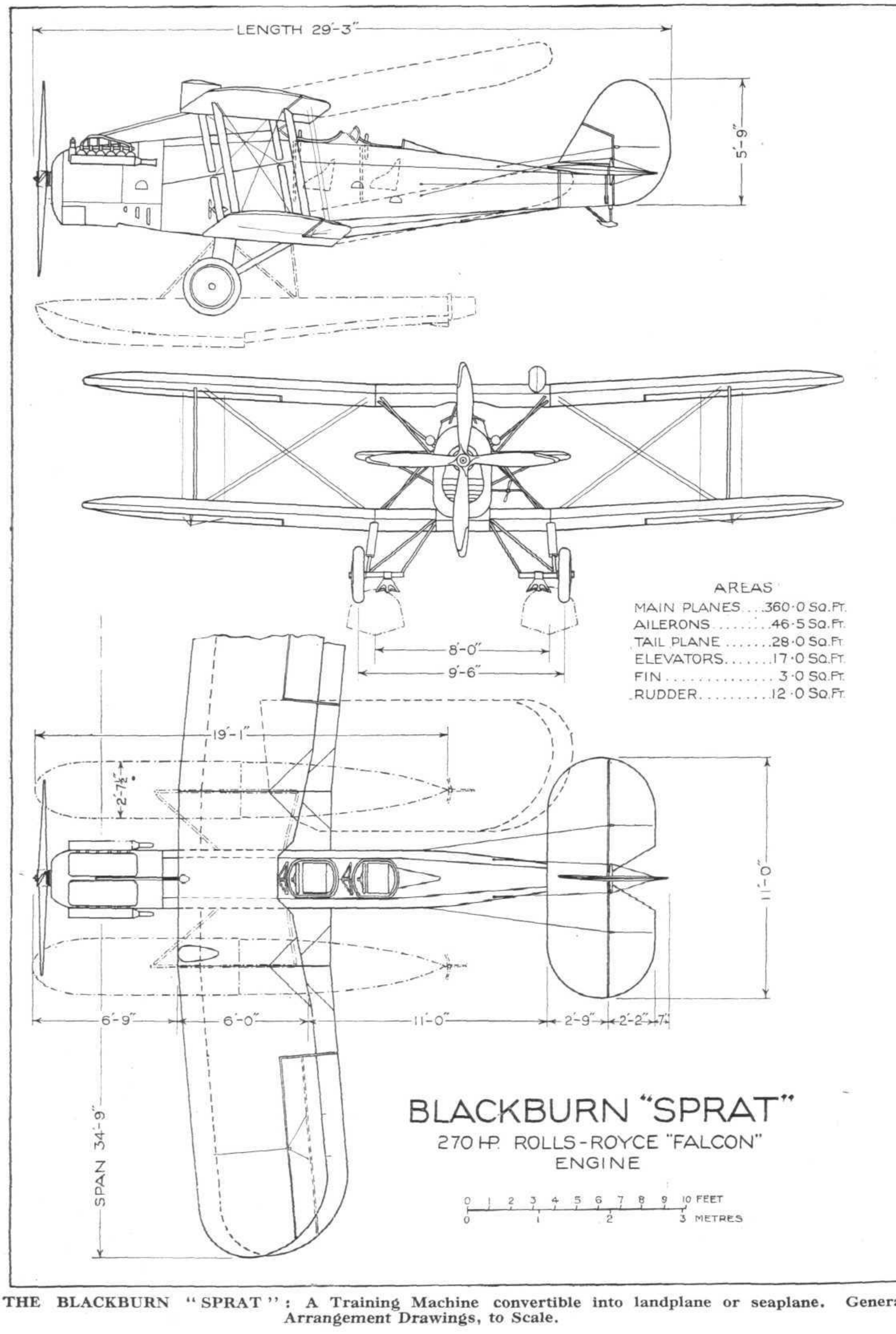
"FLIGHT" *Photograph*

THE BLACKBURN "SPRAT": This front view shows the divided undercarriage, for which a float chassis can be substituted.

The accommodation for pupil and instructor (the latter occupying the aft cockpit) is such that not only is communication between them made as easy as possible, but both obtain an excellent view, as they are situated aft of the trailing edge of the top plane, which is cut away near the centre. In point of fact, the view is equal to that of the "Swift" torpedo carrier, which has proved exceptionally good for deck landing work, where a good view is essential. A neat feature is the placing of the instruments on the rear top spar, where they can be seen by both occupants.

The biplane wings are of normal construction, and are designed to fold, so that in this state the machine occupies a very small space.

The land undercarriage, as already mentioned, is similar to that of the "Swift," and has two independent halves, unconnected by axles. The shock-absorbing gear is in the form of rubber blocks in compression, a form which is becoming increasingly popular, and which has been used by the Blackburn company for several years. With the sloping centre-section struts typical of the torpedo plane, the chassis attachments are situated a fair distance out from the centre,

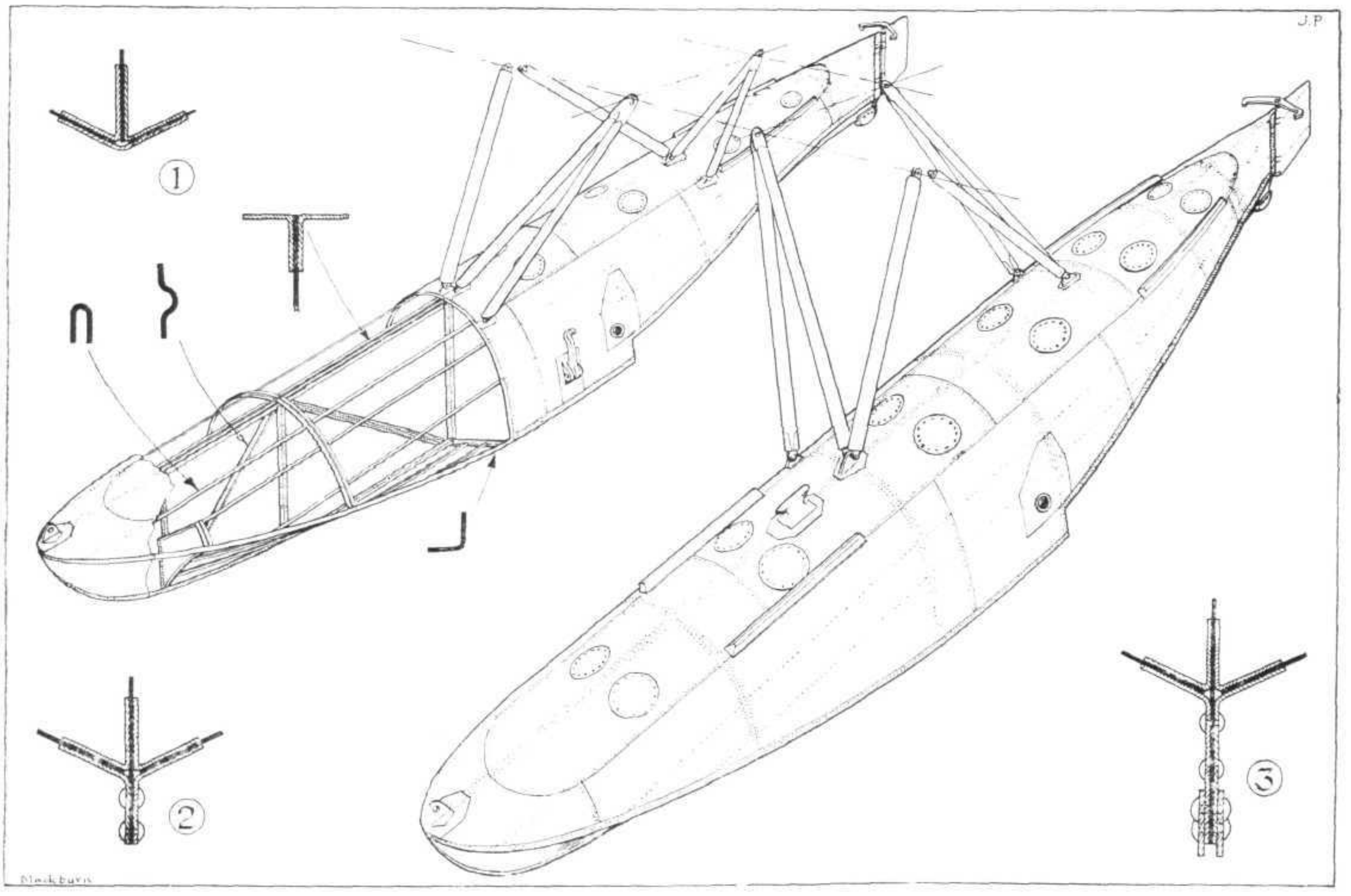


THE BLACKBURN "SPRAT": A Training Machine convertible into landplane or seaplane. General Arrangement Drawings, to Scale.

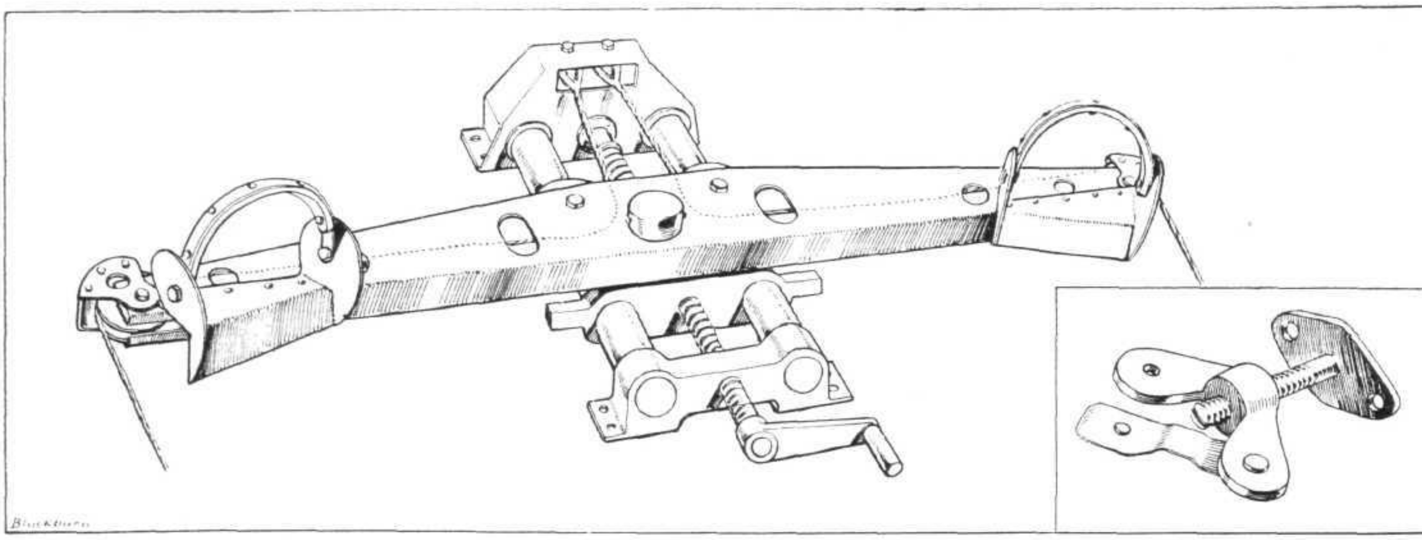
"Flight" Photograph

The Blackburn "Sprat" landing at Brough after a test flight.

thus giving a very wide wheel track and making the machine particularly stable on the ground. Moreover, the absence of any cross-members renders the machine much less likely to "nose over" if a landing in tall grass or corn should be necessary. In the illustrations the grapples used for deck landing may be seen.



THE BLACKBURN "SPRAT": Some constructional details. The main sketch shows the two Duralumin floats, with their struts. The 12 inspection holes in each float have their covers riveted on. The transverse tubes through the floats serve to accommodate the beaching chassis, to which a jack action is given by levers (not shown) held in position by catches, of which that on the starboard float is shown. The float framework is also illustrated, with sections of certain main members. At 1, is shown the joint of the keelson to keel and planking near the bows, while 2 illustrates the same joint some distance aft of the step, and 3 the joint, with steel shoe on keel, immediately aft of the step. Note that water rudders are fitted in order to give good manœuvrability on the water.



THE BLACKBURN "SPRAT": In order to accommodate pilots of different height, the foot bars are made adjustable, the means of adjustment being such that the cables are always maintained at an even tension. On the right a sketch showing a typical cowling clip with locking device.

Item Weights

We have been able to obtain from the Blackburn company a very full schedule of item weights, which should be of interest. The weights are as follows :—

Structure	Seaplane lbs.	Landplane lbs.
Float or land undercarriage ..	380	130
Fuselage (seats, floors and flotation bags)	290	290
Chassis	80	—
Engine mountings, cowls, etc. ..	80	80
Tail skid	12	12
Flight controls	65	65
Main planes	480	480
Tail unit	70	70
Total structure weight	1,457 (41 per cent.)	1,127 (35 per cent.)

The weight of the power unit is, of course, the same for the seaplane and the landplane, and is made up as follows: Engine (dry), 725 lbs.; water in engine, 25 lbs.; radiator and water, 160 lbs.; propeller, 50 lbs.; engine accessories and piping, 90 lbs.; gas starter, 65 lbs. Total weight of engine unit, 1,115 lbs. This represents a percentage weight of 31·4 for the seaplane and 34·65 for the landplane.

The items connected with the fuel, tanks, etc., are also identical for both types, and are as follows: Fuel (56 gallons), 425 lbs.; oil (4 gallons), 40 lbs.; water (1½ gallons), 15 lbs; fuel tanks, 60 lbs.; oil tank, 10 lbs.; water tanks, 6 lbs. Total, 556 lbs., which represents 15·7 per cent. in the case of the seaplane and 17·25 per cent. for the landplane.

The following military load is carried in both types of machine: Crew (2), 360 lbs.; instruments, 55 lbs.; Very pistol and 12 cartridges, 7 lbs. Total, 422 lbs., or 11·9 per cent. of the total loaded weight of the seaplane and 13·1 per cent. of the landplane. The total loaded weight of the seaplane is 3,500 lbs., and of the landplane 3,220 lbs.

Performance

Following are the estimated performances of the machine in its two forms :—

	Seaplane	Landplane
Top speed at sea level	98 knots	100 knots
Top speed at 5,000 ft.	95 knots	100 knots
Climb (sea level)	937 ft./min.	1,100 ft./min.
Time to 5,000 ft.	6¼ mins.	5½ mins.
Time to 10,000 ft.	16 mins.	13 mins.
Service ceiling	15,700 ft.	17,500 ft.
Landing speed	40 knots	39 knots

R.A.F. Cairo-Cape-Cairo Flight

THE four R.A.F. Fairey IIID biplanes (Napier "Lions") under Wing-Commander Pulford, resumed the return journey to Cairo on May 20, flying from Mongalla to Malakal. The following day they proceeded to Khartoum, and on May 25 they arrived at Wadi Halfa.

The Polar Flights

FOLLOWING on Capt. Amundsen's successful Polar flight in the airship "Norge," President Coolidge has sent the following congratulatory message to King Haakon of Norway: "I desire to offer your Majesty and the people of Norway my congratulations on the success which has attended the bold undertaking of this hardy and intrepid descendant of the Vikings. It is a matter of great satisfaction that one of my countrymen should be associated with him in this daring and courageous exploit." He also sent a similar message to the King of Italy.

Lieut.-Commander Byrd, who flew over the North Pole in a three-engined Fokker just before Amundsen's similar achievement, and members of his expedition, have left King's Bay for London. It is stated that another expedition is to be organised for a flight over the South Pole.

French Long-Distance Flights

THE first of a series of long-distance flights planned by the French Air Department commenced on May 25, when Capt. Pelletier D'Oisy left Villacoublay in a Potez biplane 450-h.p. Lorraine Dietrich) on his second aerial trip to Tokyo. This time, accompanied by M. Henri Carol, he will fly via the following stages :—Moscow (1,700 miles), Kurgan (1,250 miles), Krasnoyarsk (1,125 miles), Irkutsk (562 miles), Peking (1,062 miles), Haiju (531 miles), and Tokyo (1,000 miles)—a total distance of 7,230 miles.

A Polish Paris-Tokyo Flight

THE Polish pilot, M. Orlinski, left Paris on May 24 with the object of flying to Tokyo via Russia and Siberia.

A New York-Buenos Aires Flight

SENOR BERNARDO DUGGAN, an Argentine sportsman, left New York on May 24 in a Savoia flying-boat piloted by Capt. E. Oliveiro, and accompanied by Lieut. E. Campanelli (who was Pinedo's engineer in the Rome-Tokyo-Rome flight), with the intention of flying to Buenos Aires, a distance of 5,300 miles. He reached Hampton Roads safely and proceeded next day to Charleston, S. Carolina.

Waziristan Clasp to India General Service Medal

THE Air Ministry announces :—His Majesty the King has been graciously pleased to command that the India General Service Medal, 1908, in silver, with clasp "Waziristan, 1925," shall be granted for the Royal Air Force operations carried out in Waziristan between March 9-May 1, 1925, under the command of Wing Commander (now Group Captain) R. C. M. Pink, C.B.E., Royal Air Force. Detailed particulars as to the conditions under which the medal and clasp will be awarded, and as to the method in which applications are to be submitted, will be promulgated at a later date.

The AIRCRAFT ENGINEER

FLIGHT ENGINEERING SECTION

Edited by C. M. POULSEN

May 27, 1926

CONTENTS

OUR CONTRIBUTORS

Captain F. S. Barnwell, the first instalment of whose article was published last month, concludes in the present issue his exposition of a suggested method for attaining stability in the original lay-out of an aeroplane design. As pointed out in the April 29 issue of THE AIRCRAFT ENGINEER, Captain Barnwell's article is a somewhat lengthy one, so that it was found impossible to publish it in one issue. Consequently, some of the illustrations were given last month, the remaining ones being published in the present issue. In the text published last month, reference was made to some of the illustrations now given, and similarly this month reference is made to the illustrations published in the first instalment.

It will be found, we think, that the empirical method suggested by Captain Barnwell, if used with discretion and commonsense, is capable of giving good results, although in certain respects it may not be entirely beyond criticism. We should appreciate, as would also the author of the article, the views of readers on the different points raised, and shall be pleased to devote any reasonable space in the Correspondence columns of FLIGHT to a discussion of the method.

Mr. J. D. North, whose series of articles on aircraft performance has aroused very great interest, continues in the present issue with a discussion of scale effect, and points out that the phenomenon which we commonly call interference, *i.e.*, the change in air flow around a body caused by the presence of other bodies near it, is likely to be subject to considerable scale effect. Mr. North makes the interesting observation that the failure of modern machines to give the performance, and particularly the climb, which their lower-power loading would indicate, may be due to the larger bodies of modern machines as compared with earlier aeroplanes.

Dr. Leslie Aitchison, whose articles on the subject of Duralumin have contributed greatly to a wider knowledge of the peculiarities and treatment of this interesting material, deals in the present issue with methods of heating Duralumin, notably the salt bath, and calls attention to the necessity for allowing ample time for the metal to reach the desired temperature.

A SUGGESTED METHOD FOR ATTAINING STABILITY IN THE ORIGINAL LAY-OUT OF AN AEROPLANE DESIGN

By F. S. BARNWELL

(*Concluded from page 40*)

Lateral Stability.

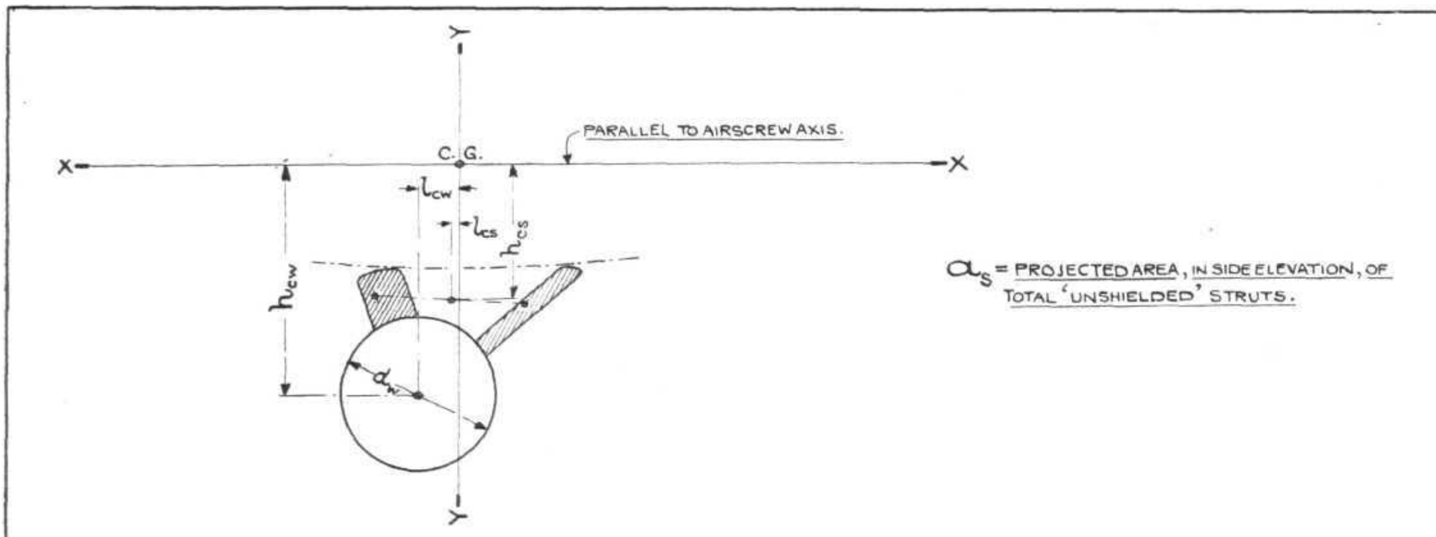
Consider the case of an aeroplane, flying steadily along a rectilinear flight-path, being given (by a momentary use of the controlling surfaces, or by a veering in the direction of the wind) a certain degree of yaw to its flight-path, say, of tail-to-port attitude :—assuming that the fin surface be sufficient to give "stability in yaw," the tail of the aeroplane will commence to swing to starboard and this rotation in yaw will (by causing the speed of the starboard wing tip to become greater than that of the port wing tip) cause the aeroplane to commence rotating in roll (or "banking") in the port wing tip down direction; assuming, to simplify the argument (it is also approximately true) that the oscillations in yaw and in roll be "dead beat," it follows that the aeroplane tends to "finish up" with a certain amount of port wing tip down "bank"; but such attitude entails side slip to port (equivalent, of course, to yaw in tail-to-port attitude, again); hence the procedure will continue, the rate of yawing and the angle of bank "building up." In the foregoing it has been assumed, of course, that there is *no* rolling moment due to an *attitude* of yaw.

To attain lateral stability it is necessary that the aeroplane possess, in addition to a certain degree of "stability in yaw," a certain degree of "stability in roll" ("stability in roll" being taken as of the sense previously defined for coefficients of rolling moment).

In the particular case being considered, should the aeroplane possess some degree of "stability in roll," it will commence to "bank" port wing tip up in addition to commencing to yaw tail to starboard; and, should the relative values of "stability in roll" and "stability in yaw" be correct, the aeroplane will "finish up" on an "even keel," meaning that it possesses lateral stability in the sense originally defined.

Put in another form, if for any aeroplane the value $\frac{\delta L}{\delta N}$ be correctly adjusted, the aeroplane will be laterally stable.

If the value of $\frac{\delta L}{\delta N}$ be too small, the machine tends to a condition of increasing rate of yawing and increasing bank, "spiral instability"; whilst, if the value of $\frac{\delta L}{\delta N}$ be too large,



$$\delta Y_C = (\delta Y_{cw} + \delta Y_{cs}) = (\cdot 0136\, d_w^2 \times n^*) + (\cdot 02 \times a_S)$$

$$\delta L_C = -[(\delta Y_{cw} \times h_{cw}) + (\delta Y_{cs} \times h_{cs})]$$

δM_C TAKEN AS ZERO

$$\delta N_C = -[(\delta Y_{cw} \times l_{cw}) + (\delta Y_{cs} \times l_{cs}) + (\cdot 0013\, d_w^3 \times n^*)]$$

* n = NUMBER OF WHEELS.
l_{cw} & l_{cs} ARE +VE IF AHEAD OF Y-Y.
h_{cw} & h_{cs} " " " BELOW X-X.

Fig. 3.—Values for lateral force and moments due to undercarriage.

the machine tends to a condition of yawing from side to side with increasing amplitude, "instable lateral oscillation."

If in two different aeroplanes :—

(*a*) Ratio of "stable" rolling moment (due to a small angle of yaw, β_1) to "stable" yawing moment (due to same small angle of yaw, β_1) be the same,

(*b*) Ratio of moment of inertia in roll to moment of inertia in yaw be the same,

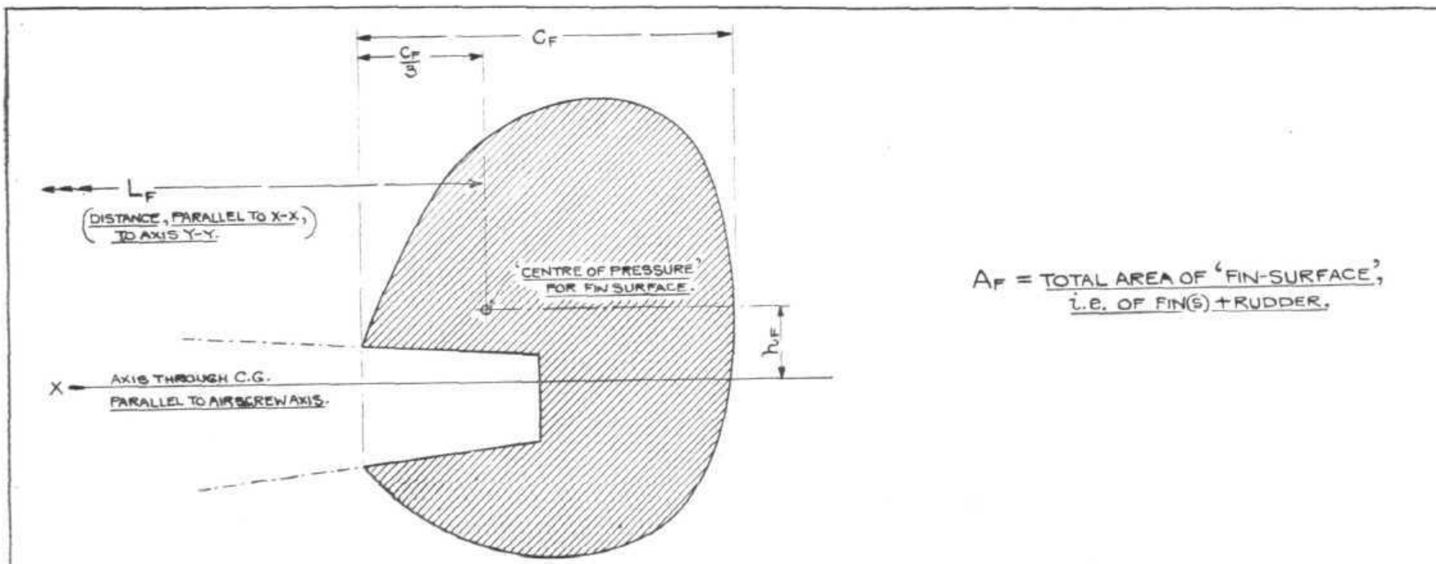
(*c*) The relative values of all the "rotary derivatives" be the same,

(*d*) Ratio of total lateral force (due to same small angle of yaw, β_1) to total weight of aeroplane be the same,

then will these two aeroplanes be similar in their lateral stability characteristics.

As regards (*b*), for machines of the same type (*i.e.*, say, "tractor biplanes") it is probable that the ratio between the moments of inertia will be fairly constant; further, the alteration in ratio from that of some known case can be estimated fairly simply and can probably be allowed for with a reasonable degree of accuracy.

As regards (*c*), it is assumed that the "rotary derivatives," in yaw and in roll, vary in the same sense, and in approximately the same proportionate amounts, as do the "static" yawing and rolling moments. For example, any change in area, shape or position of fin surface which increases its "stable" yawing moment (at some small angle of yaw, β_1) will increase, and increase by much the same proportionate amount, the value of its "rotary derivative" in yaw (*i.e.*, yawing moment due to yawing divided by rate of yawing).



$$\delta Y_F = \cdot 019 A_F$$

$$\delta L_F = (\delta Y_F \times h_F)$$. h_F IS +VE WHEN 'C.P.' IS ABOVE X-X.

δM_F TAKEN AS ZERO.

$$\delta N_F = (\delta Y_F \times L_F)$$

Fig. 4.—Values for lateral force and moments due to "fin surface."

As regards (*d*), it is assumed that the ratio of lateral force to weight is of secondary importance only and is unlikely to vary to an extent which would cause serious alteration of the stability characteristics.

Lateral acceleration tends, of course, to decrease rate of wing, but the decrease is of small relative value.

To attain lateral stability, then, we have arrived by way of arguments (probably neither too wise nor too good) at this conclusion :—

Given an aeroplane A, whose lateral stability is considered satisfactory, then, in the original lay-out for some new aeroplane B—

(1) Make area of fin surface such that, per degree of angle of yaw, ratio of "stable" yawing moment (due to this fin surface) to "instable" yawing moment (due to rest of machine *less* fin surface) is the same as that for aeroplane A.

(2) Give such a dihedral angle to the wings that, per degree of angle of yaw, the ratio of "stable" rolling moment for complete machine to "stable" yawing moment for complete machine is the same as that for aeroplane A.

The lateral stability characteristics of aeroplane B should then be very much the same as those of aeroplane A.

In estimating the values of rolling and yawing moments it is assumed that :—

Total "instable" yawing moment (of whole aeroplane *less* fin surface) is the algebraic sum of the yawing moments due to airscrew, body, undercarriage and wings ;

That total yawing moment is the difference between the "stable" yawing moment (due to the fin surface) and the total "instable" yawing moment (just defined) ;

That total rolling moment is the algebraic sum of the rolling moments due to airscrew, body, undercarriage, fin surface and wings.

In Fig. 1 are given empirical equations for determining the values of δL_P (rolling moment per degree of yaw divided by ρv^2) and of δN_P (yawing moment per degree of yaw divided by ρv^2), due to the airscrew.

In Fig. 2 are given empirical equations for determining the values of δL_B (rolling moment per degree of yaw divided by ρv^2) and of δN_B, (yawing moment per degree of yaw divided by ρv^2), due to the body.

In Fig. 3 are given empirical equations for determining the values of δL_C and δN_C the similar moment factors due to the undercarriage.

In Fig. 4 are given those for determining δL_F and δN_F, the similar moment factors due to the fin surface.

In Fig. 6 those for determining δL_W and δN_W, the similar moment factors due to the wings.

Assuming that the original lay-out of a new aeroplane has been completed (save only for the fin surface and the dihedral angle of the wings), that the position of the centre of gravity has been estimated and the stability in pitching settled, the empirical procedure for attaining the desired degree of lateral stability is as follows :—

(1) Calculate, by these empirical equations, the values for :—

δN_P, δN_B, δN_C and δN_W, assuming temporarily some initial "trial" value for dihedral angle (say 3°).

Give then such area of fin surface that

$$\delta N_F = -C_2(\delta N_P + \delta N_B + \delta N_C + \delta N_W) \quad \ldots\ldots\ldots\ldots \quad (3)$$

C_2 should have some value between 1·5 and 2·0, dependent primarily upon the degree of lateral stability required. It should be noted that C_2 is, in addition to being an empirical "measure" of "stability in yaw," actually *the* empirical "measure" of lateral stability because once the degree of "stability in yaw" has been fixed (by fixing upon some value for C_2) the degree of "stability in roll" must (as before expounded) be made to correspond.

The value of C_2 is dependent, to a secondary degree, upon the ratio of length of radius of gyration about axis Y-Y to length of "fin lever" (L_F in Fig. 4). For approximately the same degree of "stability in yaw" it appears reasonable to assume that C_2 should vary linearly as $\frac{k_Y}{L_F}$ where k_Y is length of radius of gyration about axis Y-Y.

For the "Bristol Fighter"

$$\frac{k_Y}{L_F} = \frac{5 \cdot 90}{15 \cdot 2} \doteq 0 \cdot 39$$

Hence one might say that C_2 should have some value between

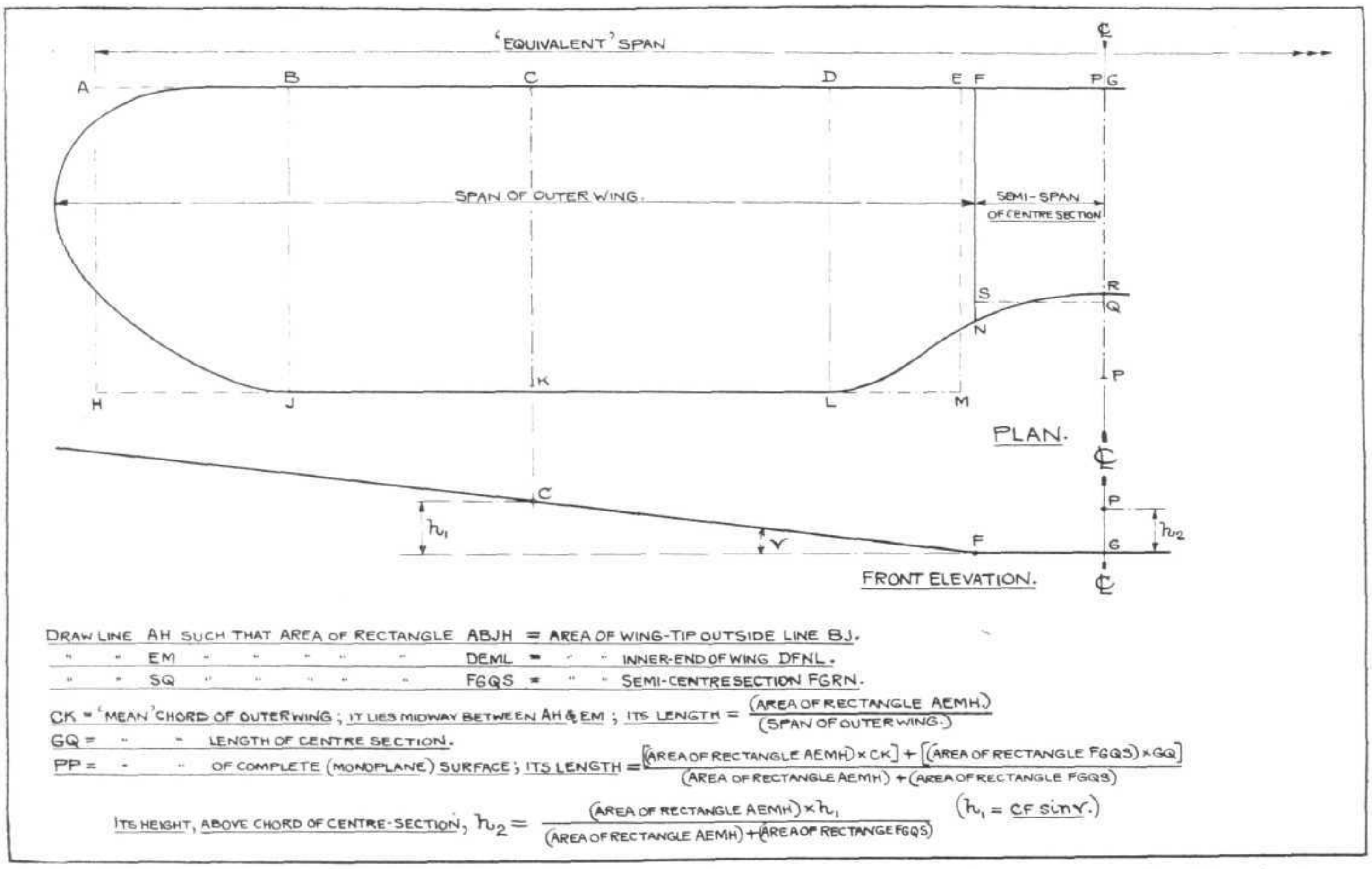


Fig. 7.—Approximate method for determining "mean" chord and "equivalent" span ("monoplane" surface).

$$3\cdot 9\,\frac{k_Y}{L_F} \text{ and } 5\cdot 2\,\frac{k_Y}{L_F}$$

depending upon the degree of lateral stability required.

[Let me state that I have quoted figures for radii of gyration of the "Bristol Fighter" because it is the only machine for which I have ever made fairly careful and elaborate calculations for these values.]

(2) Calculate, by these empirical equations, the values for :—

δL_P, δL_B, δL_C, δL_F and δL_W, retaining, of course, the initial "trial" value for dihedral angle, and thence calculate the value of C_3 from the equation

$$C_3 = \frac{\delta L_P + \delta L_B + \delta L_C + \delta L_F + \delta L_W}{\delta N_P + \delta N_B + \delta N_C + \delta N_F + \delta N_W} \qquad (4)$$

C_3, the empirical "lateral stability factor," should have a value of about $3\cdot 0$.

The value of C_3 is dependent to some degree upon the ratio between moments of inertia in roll and yaw, and it seems reasonable to assume that it should vary linearly as $\frac{k_R}{k_Y}$ where k_R is length of radius of gyration in roll, and k_Y is length of radius of gyration in yaw.

Now for the "Bristol Fighter,"

$$\frac{k_R}{k_Y} = \frac{4\cdot 33}{5\cdot 90} \doteq 0\cdot 73.$$

Hence one might say that C_3 should have a value of about $4\cdot 1\,\frac{k_R}{k_Y}$.

It should be noted that departure from the correct value for C_3 does *not* alter the degree of lateral stability *but tends to produce instability.*

(3) If C_3 (as is most likely) be not of the required value with the initial "trial" dihedral angle, a second "trial" value must be taken and the calculations amended accordingly. Generally by careful inspection of the values arrived at with the initial "trial" dihedral it is possible to choose the second "trial" dihedral so as to attain the desired end (say C_3 value correct to plus or minus $0\cdot 1$); but if not, a third "trial" must be made.

That concludes the empirical procedure for lateral stability, but I think that one point of great importance had better be noted with respect to the value for δY_F given in Fig. 4. This value is approximately accurate for a fin surface of the proportions here drawn, situated approximately as here drawn on a body which is reasonably tapered in plan, say no "blunter" than that shown in Fig. 2; but the value for δY_F varies very greatly with alteration in shape of fin surface, with position of fin surface on body and with the dimensions of the fin surface compared to those of the rear end of the body.

All the empirical values, given in the figures, for forces and moments, have been worked out from data given in various reports of the Advisory Committee on Aeronautics on work done at the National Physical Laboratory; they represent, I believe, fair average values. *Coefficients of yawing moment on bodies, of lateral force on fin surfaces and of normal force on tail surfaces have, in addition, been checked by a considerable amount of experimental work carried out in the wind tunnel of the Bristol Aeroplane Co.*

The suggested values for the empirical "measures" C_1 and C_2, and for the empirical "factor" C_3, have been arrived at by making the calculations (as set forth herein) for a $\frac{1}{8}$th scale model of aeroplane SE5A and for numerous "Bristol" machines. The particulars for SE5A were obtained from R. & M. No. 831, published in the 1923-4 Technical Report of the Aeronautical Research Committee. This particular R. & M. was of great value in the matter because in it are given values for forces and moments on the complete model as determined in the wind-tunnel at the National Physical Laboratory, hence it provided a cheque on the accuracy of these empirical methods of calculating these forces and moments [it should be stated that I had worked out and decided upon the various force and moment coefficients before I obtained this R. & M.].

To clear up any points on the suggested procedure which may have been insufficiently expounded, I give, in Appendix A, these empirical calculations carried out for the SE5A model; as a matter of interest, I give, in Appendix B, a comparison between the values obtained by these calculations and the values determined experimentally in the wind tunnel.

In conclusion, I must express my indebtedness to the National Physical Laboratory for providing nearly all the initial data, and to the Directors of the Bristol Aeroplane Co. for permission to quote work which has been done in the wind tunnel of that firm.

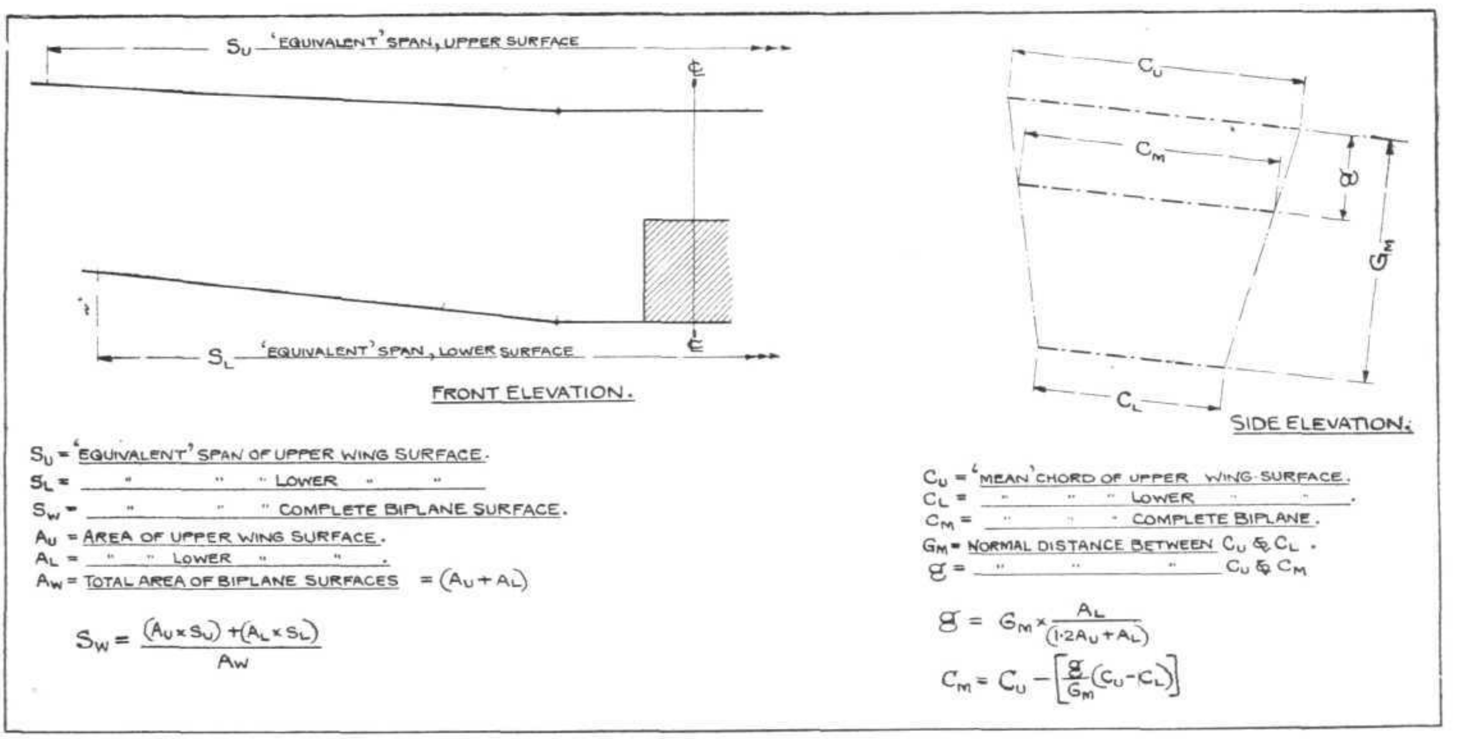


Fig. 8.—Approximate method for determining "equivalent" span and "mean" chord for a biplane from the values (previously determined) for those of the upper and lower surfaces.

APPENDIX A

Stability Calculations for SE5A Aeroplane

(Data taken from R. & M. No. 831)

Airscrew:—$d_P = 1\cdot 0$ ft. $l_P = \cdot 683$ ft. $h_P = 0$.

Hence :—$\delta Y_P = (\cdot 00105 \times 1^2) = \cdot 00105$

$\delta L_P = (\cdot 00105 \times 0) = 0$

$\delta M_P = -(\cdot 00105 \times \cdot 683) = -\cdot 00072$

$\delta N_P = -(\cdot 00105 \times \cdot 683) = -\cdot 00072$

Body :— $A_S = \cdot 775$ sq. ft. $A_P = \cdot 512$ sq. ft. $L_B = 2\cdot 35$ ft. $l_B = \cdot 621$ ft. $h_B = 0$. $\cdot 27 L_B = \cdot 635$ ft.

Hence :—$\delta Y_B = (\cdot 0045 \times \cdot 775) = \cdot 00349$

$\delta Z_B = (\cdot 003 \times \cdot 512) = \cdot 00154$

$\delta L_B = (\cdot 00349 \times 0) = 0$

$\delta M_B = -[(\cdot 0008 \times \cdot 512 \times 2\cdot 35) + \cdot 00154 (\cdot 621 - \cdot 635)] = -\cdot 00094$

$\delta N_B = -[(\cdot 0009 \times \cdot 775 \times 2\cdot 35) + \cdot 00349 (\cdot 621 - \cdot 635)] = -\cdot 00159$

Undercarriage :—2 wheels. $d_W = \cdot 279$ ft. $d^2_W = \cdot 078$. $d^3_W = \cdot 0218$. $h_{CW} = \cdot 512$ ft. $l_{CW} = \cdot 140$ ft. $a_S = \cdot 040$ sq. ft. $h_{CS} = \cdot 304$ ft. $l_{CS} = \cdot 008$ ft.

Hence :—$\delta Y_{CW} = (\cdot 0136 \times \cdot 078 \times 2) = \cdot 00212$

$\delta Y_{CS} = (\cdot 02 \times \cdot 04) = \cdot 0008$

$\delta Y_C = (\cdot 00212 + \cdot 0008) = \cdot 00292$

$\delta L_C = -[(\cdot 00212 \times \cdot 512) + (\cdot 0008 \times \cdot 304)] = -\cdot 00133$

$\delta N_C = -[(\cdot 00212 \times \cdot 140) + (\cdot 0008 \times \cdot 008) + (\cdot 0013 \times \cdot 0218 \times 2)] = -\cdot 00036$

Fin Surface :—$A_F = \cdot 194$ sq. ft. $L_F = 1\cdot 625$ ft. $h_F = \cdot 30$ ft.

Hence :—$\delta Y_F = (\cdot 019 \times \cdot 194) = \cdot 00369$

$\delta L_F = (\cdot 00369 \times \cdot 30) = \cdot 00111$

$\delta N_F = (\cdot 00369 \times 1\cdot 625) = \cdot 00600$

Tail Surface :—$A_T = \cdot 480$ sq. ft. $L_T = 1\cdot 63$ ft.

Hence :—$\delta Z_T = (\cdot 0155 \times \cdot 48) = \cdot 00744$

$\delta M_T = (\cdot 00744 \times 1\cdot 63) = \cdot 01212$

Wings :—$A_W = 3\cdot 810$ sq. ft. $C_M = \cdot 615$ ft. $S_W = 3\cdot 235$ ft. $v = 4\tfrac{3}{4}°$. $x_1 = \cdot 174$ ft. $y_1 = \cdot 178$ ft. $i_W = 4\tfrac{3}{4}°$. R.A.F. 15 section. δQ = Maximum value for alteration of Q per 1° alteration of $i = \cdot 0007$.

[The tabular calculation for values of Q is not given.]

Hence :—$\delta Y_W = [\cdot 00007 + (\cdot 00006 \times 4\cdot 75)] \times 3\cdot 81 = \cdot 00135$

$\delta L_W = [\{\cdot 00007 + (\cdot 00013 \times 4\cdot 75)\} \times 3\cdot 81 \times 3\cdot 235] + (\cdot 00135 \times \cdot 178) = \cdot 00870$

$\delta M_W = -(\cdot 0007 \times 3\cdot 81 \times \cdot 615) = -\cdot 00164$

$\delta N_W = [\cdot 000028\{1 - (\cdot 5 \times 4\cdot 75)\} \times 3\cdot 81 \times 3\cdot 235] = -\cdot 00047$

Stability in Pitch :—

$$\cdot 01212 = -C_1[-\cdot 00072 - \cdot 00094 - \cdot 00164] \text{ or } C_1 = 3\cdot 67$$

Lateral Stability :—

$$\cdot 006 = -C_2[-\cdot 00072 - \cdot 00159 - \cdot 00036 - \cdot 00047] \text{ or } C_2 = 1\cdot 91$$

$$C_3 = \frac{0 + 0 - \cdot 00133 + \cdot 00111 + \cdot 00870}{-\cdot 00072 - \cdot 00159 - \cdot 00036 + \cdot 006 - \cdot 00047} = 2\cdot 96$$

APPENDIX B

Comparison between values for lateral force and moments as determined

(1) by empirical calculations.

(2) by wind-tunnel tests on complete model for $\tfrac{1}{8}$th scale model of aeroplane SE5A.

(1) For complete machine *less airscrew* :—

$\delta Y = (\delta Y_B + \delta Y_C + \delta Y_F + \delta Y_W) = (\cdot 00349 + \cdot 00292 + \cdot 00369 + \cdot 00135) = \cdot 01145$

$\delta L = (\delta L_B + \delta L_C + \delta L_F + \delta L_W) = (0 - \cdot 00133 + \cdot 00111 + \cdot 00870) = \cdot 00848$

$\delta M = (\delta M_B + \delta M_W + \delta M_T) = (-\cdot 00094 - \cdot 00164 + \cdot 01212) = \cdot 00954$

$\delta N = (\delta N_B + \delta N_C + \delta N_F + \delta N_W) = (-\cdot 00159 - \cdot 00036 + \cdot 00600 - \cdot 00047) = \cdot 00358$

(2) From values given in R. & M. No. 831 :—

Lateral force (for $i_W = 4\tfrac{3}{4}°$) = $\cdot 0480$ lbs. per 1° of yaw.

Rolling moment (for $i_W = 4\tfrac{3}{4}°$) = $\cdot 0360$ ft.-lbs. per 1° of yaw.

Pitching moment *alters* $\cdot 0354$ ft.-lbs. per 1° *alteration* of angle of pitch.

[This is value realised between $i_W + 4°$ and $i_W = +8°$.]

Yawing moment (for $i_W = 4\tfrac{3}{4}°$) = $\cdot 0154$ ft.-lbs. per 1° of yaw.

All the above being at a value of $\rho v^2 = (\cdot 00237 \times 40^2) = 3\cdot 792$.

Hence :—$\delta Y = (\cdot 0480 \div 3\cdot 792) = \cdot 01265$

$\delta L = (\cdot 0360 \div 3\cdot 792) = \cdot 00948$

$\delta M = (\cdot 0354 \div 3\cdot 792) = \cdot 00933$

$\delta N = (\cdot 0154 \div 3\cdot 792) = \cdot 00406$

Comparative Table :—

	(1) Calculation.	(2) Experiment.	(1) ÷ (2)
δY	·01145	·01265	·905
δL	·00848	·00948	·895
δM	·00954	·00933	1·02
δN	·00358	·00406	·882

AIRCRAFT PERFORMANCE

Scale Effect

By J. D. NORTH, F.R.Ae.S.

(*Continued from p.* 43)

It will be observed from what has already been said that the advantages to be derived from the choice of wing section are limited, and that the best present practice approaches so nearly to the *optimum* which theory would lead us to expect can be attained that there is very little likelihood of much further improvement in this direction. Notable advantages, however, are to be expected from using the most suitable wing section for the particular performance and structure requirements, so that the designer is no longer restricted in his efforts to contain the structure exactly in some particular wing section the form of which has been well established. The influence of the important factor span²/weight has been emphasized and these effects of induced drag appear to hold good for full scale work. The profile drag and maximum lift coefficient, however, are much more susceptible to changes of Vl, and there are many complications introduced between the performance of the simple wing in the wind channel and the performance of the aeroplane in which the wing section is incorporated. There is first the well-known fact that flow pattern and the type of flow changes at various scales, passing from one system to another with marked consequential variations in aerodynamical properties. This fact can be demonstrated within the variations of scales which are within the reach of normal wind channels, but there is a very large jump between the highest value of wind channel Vl (*e.g.*, $Vl = 200$*) and full scale figures (about $Vl > 600$). An attempt has been made in the United States of America to bridge this gap by the construction of a channel operating on compressed air. More experience of the results of the use of this channel will be required before it will be safe to draw any very definite conclusions from the experimental evidence which it offers.

The greater part of the full scale work for scientific purposes in this country has been carried out by the Royal Aircraft Establishment, Farnborough, and the difficult nature of this work and the elaborate precautions necessarily taken to obtain accuracy reduce the amount of available evidence to very small dimensions. Ordinary aeroplane performance testing, as regards order of accuracy, is probably quite useless for analytical purposes. Not only is the total amount of full scale evidence bearing on the properties of wing sections very limited, but it is rather contradictory. Successive improvements in technique have shown different results for

* "N.P.L. Duplex Channel." Normal wind channels seldom allow more than Vl 60.

the lift properties of R.A.F. 15, a section which has been the subject of very extensive full scale research, while the moment figures on that section are equally varied. A full account of the views of the Aeronautical Research Committee on the scale effect position was published some time ago (see R. & M. 900), and this document is worthy of careful study. If one might venture a criticism of this and other admirable reports issued under the auspices of that body, I would suggest that increased attention should be paid to evidence available both in this country and abroad from sources other than those directed by the Aeronautical Research Committee, and that a tendency to draw sweeping conclusions from very limited evidence should be avoided.

One of the principal difficulties in the correlation between full scale and model work is the fact that a full scale aeroplane is generally of a complex nature aerodynamically and it is difficult to represent accurately on model scale. The profile drag of a model wing is attained by a simple and well authenticated process of calculation from straightforward tests. The order of absolute accuracy of measurement of the profile drag of any wing section between one channel and another is probably about 10 per cent. (*e.g.*, see R. & M. 935). The accuracy of the measurements in any one type of wind channel is *a fortiori* considerably higher. The determination of the profile drag of wings from measurements on a complete aeroplane is anything but simple.

If we take a good streamline body form and a good wing and join them together to represent an aeroplane, the drag and lift of the combination may be very far from the algebraic sum of these forces measured on the separate units. This difference we call interference, either interference drag or interference lift; positive interference if the drag and lift are increased, negative interference if they are decreased. The number of component parts of aeroplanes is so large and the amount of systematic investigation on the subject is so limited that no generalisation on the subject of interference resistance can be made. It is true that in R. & M. 374 the Aeronautical Research Committee suggests from the experiments on the B.E. 2 C. that component interference effects were negligible;* but no other general investigation on the matter seems to have been made since that date, except the qualification of this suggestion in R. & M. 900. These interference effects are interactions between the wing section, the interplane struts, wires, bodies, engine *nacelles*, undercarriage, &c. Interplane struts, for example, are capable of showing considerable interference effects, possibly as much as ± 100 per cent. of their own drag. This has been demonstrated on models and may or may not hold good to the same degree of magnitude at full scale. Most designers have found that much interference may take place between bodies and wings, and engine *nacelles* and wings, so far as wind channel tests are concerned, and these interferences are not constant, but vary with change of attitude. The lift is similarly subject to interference of a large order, particularly in the case of engine *nacelles*. If one may venture a generalised opinion, it seems that the magnitude of the interference increases with increased incidence, and is frequently accompanied by reduction in the maximum lift coefficient. It is not surprising that such interference takes place; on the contrary, it would be surprising if it did not. The air-flow round bodies, themselves of good streamline form, must inevitably be disturbed by the presence of other bodies, and as the interference is probably an interference of the stability of the flow, it is likely to be subject to considerable scale effect. When, therefore, we test a model aeroplane in the wind channel and its full-sized counterpart is used for determining scale effect, we are, in my opinion, entitled to say that this scale effect, within the order of accuracy of the experiments, represents scale effect from *all causes* on that particular aeroplane *only*. If there are any interferences, as there generally will be, scale effect on these interferences may be as much as any other, and it is, therefore, impossible to make any reliable deductions as to the performance of the wings alone. There is, I think, good ground for believing that interference effects are much more noticeable in machines built within the last eight years than in those constructed within the previous period. Bodies have become much larger in relation to the wing cellules. Engines and their installations are creating a greater disturbance on air flow, and high slip stream velocities are adding a further disturbing factor. Here we have good reasons why the performance (particularly on climb, where the interference becomes most important) of modern machines does not seem to represent as great an advance on their predecessors as the reduction in power loading would seem to indicate.

* "The resistances of the various parts taken separately may be added together to give the resistance of the complete aeroplane with good accuracy, provided that parts (*e.g.*, the undercarriage) which consist of a number of separate small pieces are tested as a complete unit." R. & M. 374, par. 8 (iii).

Notwithstanding these facts, there are a few general results, both from full-scale experiments and from experiments in the compressed-air channel, that would seem to indicate the general trend of scale effect on wing sections; notably, with increase of Vl, in all good forms, a steady lowering of the minimum profile drag and an increase in the general stability of flow, for thicknesses between 0·065 and 0·125 of the chord and other cambers or their equivalent reflex up to 0·04 of the chord. If we accept these values for thickness and camber as being the maximum to which it is safe to go, in the absence of any special full-scale evidence we can hardly use wing sections, designed for minimum profile drag outside the range $K_L = 0$ to $K_L = 0 \cdot 25$.

For purposes of comparison, it is most convenient to treat the strut and wire system in the main planes as a part of the wings and to express their drag as a profile drag coefficient. It is obvious that the absolute value of this resistance will depend on the span more than on the chord, so that the coefficient must be used with discretion. An investigation of a number of aeroplanes suggests a value of k_D for struts and wires between 0·0015 and 0·0025 for normal single engine aeroplanes, and 0·002 to 0·003 for twins where additional structure is involved in the engine mountings, which, being also part of the wing structure, cannot well be separated. The difference between the high and low figures is largely a matter of "ends," and interference and the value of the coefficient will frequently vary with incidence. The difference in profile drag between a good wing for braced biplane construction and that of a wing suitable for cantilever design is somewhere in the region of 0·002, which indicates little or no aerodynamical advantage for the cantilever system in respect of profile drag.

The drag of the body of the aeroplane is often masked by the resistance due to engine cooling. Particularly in the case of aeroplanes with nose radiators an appearance of streamlining is obtained not borne out by the real nature of the air flow or by the resistance. Similarly with air-cooled engines, particularly radials, 75 per cent. of the body drag is generally directly due to the engine cooling, and there is little or nothing that the aeroplane designer can do to reduce this figure.

In some cases the disturbed air flow due to the engine cooling is well away from the body—as, for example, in twin-engined aeroplanes or machines fitted with surface radiators. There is then, great advantage in drag to be gained by laying out the body lines from suitably generated forms in a manner analogous to that employed for the design of wing sections. From a knowledge of the equipment to be carried, the tail length required and other features, the length, depth, breadth, position of maximum ordinates, etc., can be decided upon and appropriate lines developed to cover any reasonable requirements.

Where this work has been properly carried out very low body drags should result. The basic shape—that is to say, the shape free from cockpits, guns, windscreens, or other obstructions—should for reasonable fineness not exceed 1½ lbs. per square foot at 100 ft. per second at best attitude, and should show but small variation with changing incidence. Where desired for reasons of general design, moderate smooth distortion of the centre line is permissible.

A powerful and adaptable weapon is by this means placed in the hands of the designer, and I believe it is true to say that a body, good in its ultimate form, must have a good basic shape. The addition of cockpits, wind-screens, guns, and other obstructions may be made one by one, and their influence on the basic shape measured in the wind channel.

Careful and systematic work will allow the necessary practical modification to be introduced with very moderate increase in drag.

Two points in respect of the above present themselves. Firstly, resistance per square foot is not alone the criterion of a good body if the size of the body has been increased above the minimum rendered necessary by the requirements of general design. The size of the body should therefore be kept as small as possible. Secondly, the construction of the body should allow the fullest possible advantage to be taken of the external dimensions in order to keep down cross-sectional area. In many cases where a large amount of internal space is required to allow free movement to the occupants, *monocoque* construction, or an approach to it, is some help in keeping down overall dimensions. Where the body is of good shape, of small dimensions in relation to the gap between the wings and appropriately placed in relation to them, body-wind interference on drag and lift may be reduced to nothing, or even be negative.

Efforts have frequently been made to reduce body-wing interference by making the body fill the *whole* gap between the wings. The evidence, for what it is worth, of the effect of this arrangement is very conflicting. I have been assured on good authority that raising the top wing of a certain aeroplane so as to give a small gap of about 2 ft. between the body and the top wing increased the speed of the aeroplane by 10 miles an hour, with a proportionately good effect on climb. In another case, a similar alteration, I am informed, has had no effect, and I believe there are claims that closing the gap has improved the performance of certain aeroplanes. One must not lose sight of the probable influence of slip-stream effects in explaining these results, but all indicate the pitfalls which await the designer who is forced to use large bodies.

In cases where the engine masks the body there seems no possibility of getting really low drag figures. The best radial engine arrangements seem to give a drag of about 4 lb. per square foot* of area measured as $\frac{\pi d^2}{4}$ where d is *engine* diameter. Full-scale performance as well as model tests seem to confirm this; it is, however, easily possible to get higher figures, particularly by the addition of exhaust rings of unsuitable aerodynamic design or by excessive air flow over the crank-case. This disturbed air flow undoubtedly has a bad effect on body-wing interference, particularly if the engine is for any reason near the wings.

* All these figures are at 100 feet per second. Further resistance figures will always be so quoted.

(*To be continued.*)

DURALUMIN

By Leslie Aitchison, D.Met., B.Sc., F.I.C., M.I.A.E.

(*Continued from p. 45*)

This process of working after quenching is particularly useful in the treatment of rivets. Rivets that have been formed in the ordinary way, and then heat-treated and aged, will not always close without cracking, simply because the metal has become so hard. This difficulty can be overcome by quenching the rivets from the normalising temperature, and then closing them up within an hour or so of the quenching operation. In this way, the cracking is avoided, and the metal in the rivet after ageing becomes possessed of its full mechanical properties. This is an alternative process to the use of annealed rivets and results in an article which is quite as trustworthy, from the point of view of freedom from cracks and, at the same time, is decidedly stronger than rivets used in the annealed condition.

In the heating of Duralumin prior to quenching, no particular points require special discussion, bar one. The exceptional point is the very considerable time that has to be allowed for Duralumin to attain to the desired temperature. Those who are accustomed to the heating of steel, either for heat-treatment or working, will find that Duralumin requires a very much greater time than the ferrous metals. This point requires very careful and special attention, as it may otherwise become a very pregnant source of unsatisfactorily treated material. It is, of course, very usual in the heating of steel to put the metal into a furnace or on to a hearth that is at a temperature much higher than that to which it is desired the metal shall attain. In many instances, it is the intention that the metal going into the furnace shall lower the heat of the furnace sufficiently to avoid any danger. Quite apart from this, it is of course also the intention that the metal and the furnace shall be brought equally to the right heat eventually, when no harm will have been done. The adoption of a similar practice with Duralumin is rather to be deprecated. The heat-treatment of steel is carried out at a temperature very far removed from the melting point of the metal. With Duralumin, the temperature of incipient melting is dangerously near that of heat-treatment, and even though the metal as a whole is not heated to any dangerous degree, the surface of the metal may become locally overheated and be blistered, and thereby develop defects which cannot subsequently be rectified. For this reason, it is highly desirable, excepting under very special circumstances and in expert hands, to utilise such methods of heating as do not permit of even temporary and local overheating of the material. That these methods of heating must be precise and readily controllable, is obvious from the fact that the range of treating temperature is so closely circumscribed.

It is generally recognised that the most satisfactory method of obtaining a uniform high temperature throughout a considerable volume of metal is to immerse it in a bath of liquid. The liquid employed would naturally depend very largely on the temperature that has to be attained, and also upon the nature of the metal that is being treated. For the light alloys, it is generally conceded that the most convenient liquid bath is that produced by a suitable fusible mixture of salts, and a very satisfactory bath for the immersion of Duralumin can be formed by mixing together equal proportions of sodium nitrate and potassium nitrate. This is not the only mixture of salts which could be used, but it is, generally speaking, as convenient as any other. The design of a suitable containing tank is not conspicuously difficult. Mild steel tanks are to be recommended, and it is desirable too that the joints in the tank shall be reinforced by riveting, even if the sealing is achieved by welding. Sharp corners should be avoided in these tanks, as they are prone to crack by expansion and contraction when the salt baths are used intermittently.

During the working of a salt bath there is always a tendency for the collection at the bottom of the bath of a certain quantity of oxide of iron together with dirt. This accumulation of foreign matter has a tendency to insulate the steel plates from the salt. This, in turn, results in an uneven heating of the plates and further scaling on the outside, with the result that sooner or later the tank is burnt through at those places where foreign matter has accumulated. To avoid this contingency it is desirable to remove the oxide and foreign matter from the bottom of the bath, by means of a perforated ladle. This operation, of course, is carried out whilst the bath is molten, and if performed at regular intervals will avoid the burning out of the plates.

Duralumin can readily be suspended in the salt baths in baskets of a suitable design. Such baskets are most conveniently made of steel, and can be made of varying capacity according to the nature of the work that is in hand. Naturally, they will be made as light as possible to avoid the extra expense of heating an idle weight of steel. For the control of the temperature of a salt bath it is probably quite sufficient to use only one pyrometer. The pyrometer that is employed should, however, be a good one and, of course, in consequence of the temperatures employed, must necessarily be of the thermo-electric or electrical resistance type. No form of optical pyrometer can be employed. It is sometimes quite feasible to utilise a thermometer of a suitable design. One of the difficulties encountered in the use of a thermometer on large baths is that of reading it without severe discomfort. A thermo-couple connected to a wall indicator is usually much more convenient. The thermo-couple should be protected by means of a stout iron tube, and should be arranged

so that it can readily be removed from the bath at the termination of the period of heating.

It is exceedingly difficult and in fact almost impossible to state with any precision the time that is required to heat Duralumin to the normalising temperature in a salt bath. The time required depends upon the type of furnace, its capacity, the nature of the material that is being heated, and the quantity that is put into the bath at any one time. All these variables have a marked effect upon the period of heating, and only adequate experience can provide the necessary information. At the expiration of the heating period, when it is reasonably certain that the immersed metal has attained to the requisite temperature, the basket and its contents are lifted out, and, after draining away as much of the salt as possible, without allowing the temperature of the metal to fall appreciably, are transferred complete to the water bosh. The water bosh should be of ample capacity to ensure that the whole of the material is immersed rapidly, but it is not of intense importance that the temperature of the water should be very low. It is desirable to quench in water that is cold, but no harm is done if the temperature has risen, say, to 60° C. The only danger that is to be apprehended from such a raising of the temperature of the quenching water is the more ready formation of steam, and the consequent blanketing of certain portions of the metal from direct access to the water, with resulting lower rates of cooling and greater distortion. So far as the mechanical properties of the metal are concerned, thin parts quenched in boiling water will give results that are not appreciably different from those obtained when the same parts are quenched in ice-cold water. Any dangers attending the use of hot water for quenching are not connected with the resulting mechanical properties of the Duralumin in general.

It is desirable that the water bosh shall be arranged for a continuous stream of water to run through it, as this allows the Duralumin to be washed whilst it is in the bosh. Naturally at the time the Duralumin is removed from the salt bath and plunged into the water bosh, it is covered with a film of salt. This film of salt will be dissolved by the water, so that in a short time the quenching bosh becomes not a water bosh, but a bosh of salt solution. When the Duralumin is removed from the bosh and allowed to drain and dry, the water evaporates away and leaves a deposit of salt on the surface of the metal. Salt solutions are prone to set up corrosion on Duralumin, and it is desirable to remove the salt from the metal completely, so that no sediment is left on the surface after treatment, to be a source of trouble subsequently. As has already been stated, this can be achieved very conveniently by using a large bosh through which the water is circulating freely and continuously whilst the metal is immersed therein.

Although a salt bath produces very satisfactory results, it is by no means the only way in which Duralumin can be heated. Salt baths are necessarily somewhat messy and not particularly cheap to operate, whilst the problem of the removal of salt from the material after treatment is one that has always to be borne in mind. There is obviously, therefore, a premium upon any method of heating which will avoid these various disadvantages. The only satisfactory method of heating which avoids the disadvantages of a salt bath is the use of muffle furnaces. These furnaces can be heated either electrically, by gas, or by solid fuels. The choice of the type of furnace will depend very considerably upon the size of the work that has to be treated. For large work it is no doubt most economical to use coke or coal-fired furnaces, whilst gas or electricity can usually be used most satisfactorily for smaller muffles. When Duralumin is being treated in this way the difficulty of ensuring the maintenance of a uniform temperature throughout the muffle is comparatively intense. The treating temperature of Duralumin is a " black heat," and no visual assistance can be obtained respecting the temperature of the muffle and the metal. It is exceedingly unlikely in general that furnaces of any appreciable size can be maintained accurately at the treating temperature, unless a comparatively elaborate pyrometric system is installed. With muffle furnaces it is also necessary to make adequate arrangements for the transfer of the material from the furnace to the quenching bosh, as it is not possible to operate with a crane in the simple manner that applies to salt-bath heating. A further difficulty is that of ascertaining when the metal has definitely attained to the temperature of the furnace. This is a severely practical problem, regarding which no definite rules can be laid down, but it has always to be appreciated that Duralumin takes a considerable time to become heated uniformly through its mass, and there is always considerable danger of non-uniform and inadequate heating when employing furnaces of the muffle type.

Duralumin that has been treated and quenched is necessarily wet when it emerges from the water bosh. The metal should not be allowed to remain in this condition, but should be dried as rapidly as possible. The material can be allowed to drain off the majority of its moisture. It may then be dried with sawdust, or may be dried with steam, as re-heating the material to a temperature round about 100° C. has no deleterious effect upon its mechanical properties. If the Duralumin is going to be put through operations straight away, no surface protection is necessary, but if the material is to be put into stores or is to wait some time for the next operation, it is highly desirable that some measures should be taken to avoid corrosion during the intervening period.

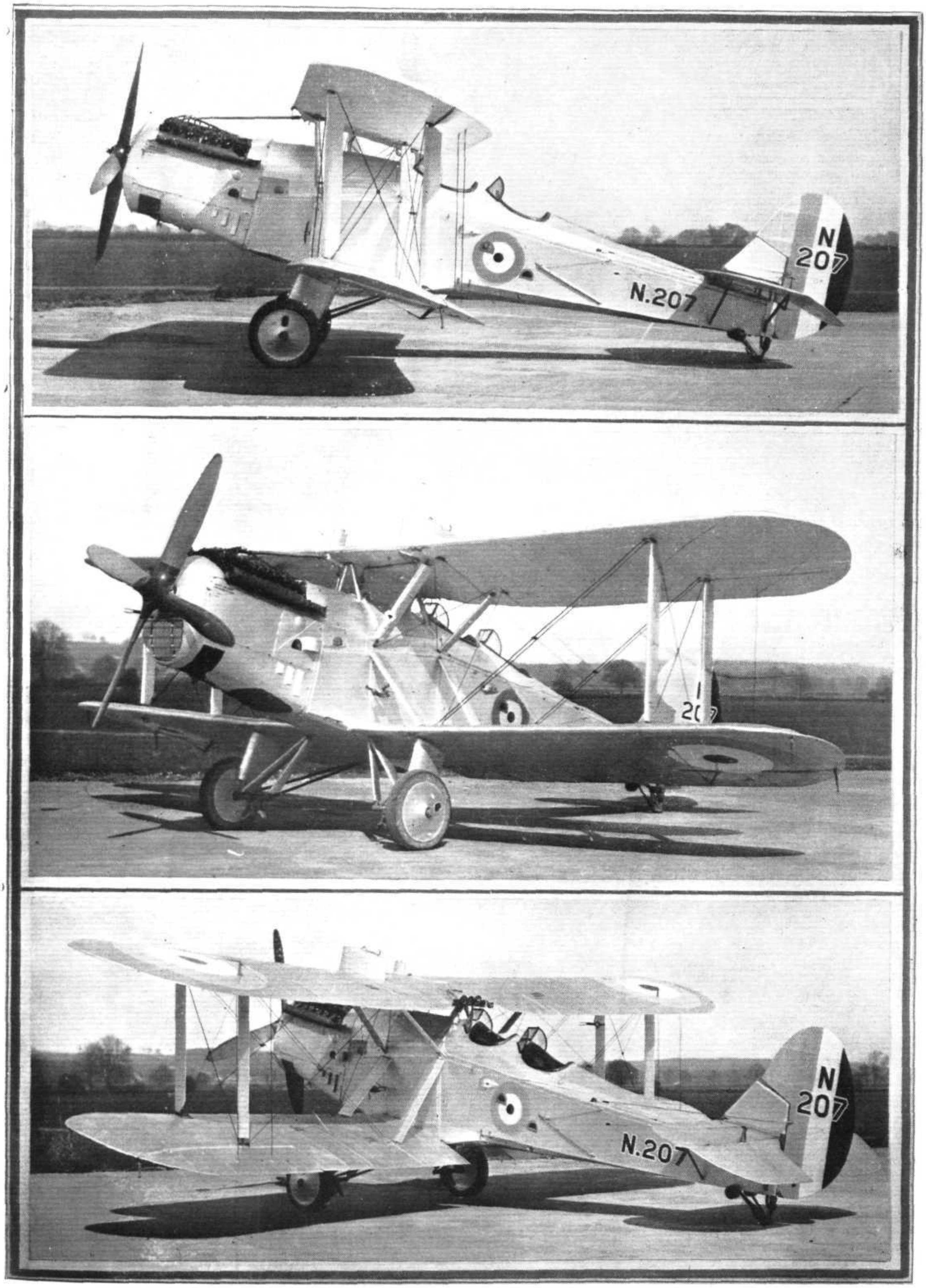
This question of the corrosion of Duralumin deserves full consideration, and before dealing with the temporary protectives that could be employed to avoid corrosion while Duralumin is being stored, it is probably desirable to consider the whole question of the corrosion of Duralumin. Such a consideration is particularly desirable, in view of the multifarious statements that have been made on the subject and the variety of opinions that have been expressed as to the capacity of Duralumin to resist corrosion. It seems very desirable, therefore, to ensure that the question of the corrodibility of the metal is viewed from the right angle, and that a proper perspective of the position is obtained.

Under certain conditions Duralumin is, of course, subject to definite corrosion, and the conditions that produce the most severe corrosion of Duralumin are to all intents and purposes the same as those that induce a marked corrosion on ordinary steels. If Duralumin is kept dry it will not corrode at all, and the free access of moisture is necessary for corrosion to be set up. Ordinary fresh water has but little corrosive effect on Duralumin, and in this medium the resistance of Duralumin to corrosion is decidedly superior to that of ordinary steels. In acid solutions Duralumin again is not at all prone to attack, and, in fact, Duralumin resists acid attacks more satisfactorily than is the case with the majority of steels. On the other hand, in alkaline media Duralumin is attacked very much more readily than steel is, and it is not generally desirable to expose Duralumin to the attack of an alkaline medium. In general, of course, very few metals are exposed to the attack of either an acid or an alkali in the free state anything like so frequently as they are exposed to the attack of saline solutions, and it is to these last conditions that the greatest amount of attention has to be paid. When exposed to saline solutions, both steel and Duralumin corrode to a characteristic extent. The behaviour of Duralumin, when exposed under these cirumstances, is of great interest and of very considerable practical importance.

(*To be continued.*)

THE PRACTICAL SIDE

From the fact that the last issues of THE AIRCRAFT ENGINEER have contained mainly articles of a "theoretical" nature it must not be assumed that we do not wish to cater for the "practical" side of aircraft engineering. In point of fact, we desire to help in every way possible by rendering accessible to the widest circles of readers information of every kind that is likely to be of interest and assistance in all branches of aircraft work. Consequently we shall welcome contributions on practical subjects such as workshop methods, the use of jigs, labour-saving devices, etc., as well as articles dealing with drawing office organisation, time-saving "dodges," &c. All articles accepted will be paid for.—ED.



"Flight" Photographs

THE BLACKBURN "SPRAT," three views of which are shown above, is a training machine convertible into a landplane or seaplane. The engine fitted as standard is a Rolls-Royce "Falcon" of 275 h.p.

The Royal Aero Club of the United Kingdom

OFFICIAL NOTICES TO MEMBERS

AIR TRANSPORT

(Organised and conducted by The Royal Aero Club for the delivery of Newspapers by Air during the Strike.)

London Aeroplane Club.

G-EBMF.—D.H. " Moth " 27/60 h.p. Cirrus (Pilot, Capt. F. G. M. Sparks), 3,384 miles flown.

G-EBNP.—D.H. " Moth " 27/60 h.p. Cirrus (Pilots, G. T. Witcombe and Squad.-Leader M. E. A. Wright), 3,225 miles flown.

Mrs. Eliott-Lynn.

G-EBKT.—D.H. " Moth " 27/60 Cirrus (Pilot, Mrs. Eliott-Lynn), 1,745 miles flown.

De Havilland Aircraft Co., Ltd.

G-EBKU.—D.H. " Moth," 27/60 Cirrus (Pilots, R. W. Reeve, F. T. Courtney, C. D. Barnard), 1,642 miles flown.

G-EBMV.—D.H. " Moth " 27/60 h.p. Cirrus (Pilots, S. L. F. St. Barbe, F. T. Courtney, A. S. White), 1,819 miles flown.

G-EBMP.—D.H. " Moth," 27/60 h.p. Cirrus (Pilot, Capt. F. G. M. Sparks), 170 miles flown.

G-EBLH.—D.H.9, Siddeley-Puma (Pilots, S. L. F. St. Barbe, R. W. Reeve, F. T. Courtney), 2,125 miles flown.

G-EBFQ.—D.H.9, Siddeley-Puma (Pilots, A. S. White, R. W. Reeve, F. T. Courtney), 3,025 miles flown.

G-EBEZ.—D.H.9, Siddeley-Jaguar (Pilots, C. D. Barnard, F. T. Courtney, R. W. Reeve), 3,290 miles flown.

A.D.C. Aircraft Ltd.

G-EBKV.—D.H.9, A.D.C. Nimibus (Pilot, H. H. Perry), 910 miles flown.

G-EKBO.—D.H.9, Siddeley-Puma (Pilots, L. Hamilton, L. P. Openshaw), 880 miles flown.

G-EBLC.—D.H.9a, Liberty (Pilots, Flying Officer N. Vintcent, H. H. Perry), 1,630 miles flown.

G-EBIO.—Bristol, Hispano (Pilot, L. Hamilton), 1,160 miles flown.

Bristol Aeroplane Co., Ltd.

G-EBFU.—Bristol, Siddeley (Pilots, W. Ewens, P. T. Holmes, C. R. L. Shaw), 550 miles flown.

British Aviation Insurance Group.

G-EBJW.—D.H.9, Siddeley-Puma (Pilot, F. D. Travers), 360 miles flown.

Berkshire Aviation Co.

G-EAKX.—Avro (Pilot, J. D. Parkinson), 1,065 miles flown.

G-EBKX.—Avro (Pilot, E. R. Beck), 1,065 miles flown.

G-EBKB.—Avro (Pilot, C. F. Kent), 1,065 miles flown.

G-EASF.—Avro (Pilot, L. Leleu), 825 miles flown.

Southern Counties Aviation Co.

G-EBSG.—Avro (Pilots, R. H. Leavey, L. A. Lewis), 1,616 miles flown.

G-EAAY.—Avro (Pilot, L. A. Lewis), 540 miles flown.

G-EBKS.—Avro (Pilot, H. Lawson), 1,083 miles flown.

Total miles flown = 33,174.

This transport was operated from bases established at Lympne, Brooklands, Hendon, Edgware, Yeovil, Plymouth, Bristol and Croydon.

In addition to the above, Air Transport of newspapers was carried out by the following :—

Surrey Flying Services.

G-EBEP.—D.H.9, Siddeley-Puma (Pilot, Lieut.-Col. Henderson), 5,046 miles flown.

Three Avros, 3,053 miles flown.

Newcastle Aero Club.

G-EBLY.—D.H. " Moth," 27/60 h.p. Cirrus.

G-EBLX.—D.H. " Moth," 27/60 h.p. Cirrus.

(Pilots, Major Packman, Baxter Ellis and P. F. Heppell), 3,460 miles flown.

Offices : THE ROYAL AERO CLUB,

3, CLIFFORD STREET, LONDON, W. 1.

H. E. PERRIN Secretary.

LIGHT 'PLANE CLUB DOINGS

London Aeroplane Club

FLYING was resumed on Thursday, May 20. For the four days May 20–23 the flying time was 27 hours 40 minutes. The following Members had flying instruction :—G. Quirk, T. H. O. Richardson, G. Black, K. V. Wright, G. Lyon, C. E. Murrell, G. H. Weston, G. Wallcousins, A. Lees, Sir John Rhodes, E. D. Moss, O. J. Marstrand, W. Hay, J. C. Parkinson, B. B. Tucker, Mrs. Lees, L. J. C. Mitchell, Miss O'Brien, D. P. H. Esler, R. C. Presland, R. Malcolm, Mrs. Eliott-Lynn.

The following Members made solo flights :—A. R. Ogston, G. H. Craig, L. J. C. Mitchell, J. S. M. Michie, G. N. Warwick, G. Wallcousins, A. Lees, Sir John Rhodes, H. Kennedy, E. S. Brough, W. Hay, A. P. Hunt, W. Roche Kelly, Mrs. Eliott-Lynn.

The Newcastle-upon-Tyne Aero Club

REPORT for week ending May 23 : Flying on LX 24 hours 25 mins., LY 19 hours 20 mins., total 43 hours 45 mins., made up as follows :—

Dual, 27 hours 20 mins. ; solo, 13 hours 15 mins. ; passenger, with Major Packman, 2 hours 20 mins. ; tests, 50 mins.

The following members flew under instruction (with Major Packman) :—Miss J. Ellis, Col. Sir Joseph Reed, Messrs. M. Bainbridge, F. H. Phillips, R. Miesegaes, C. Thompson, T. R. MacMillan, W. B. Harrison, T. E. M. Wardill, L. Smith, J. Stewart, M. G. Thirlwell, J. M. Campbell, J. Ball, J. G. Edmundson.

Solo, T. R. MacMillan, R. Miesegaes.

The following pilot members flew with passengers :—Mr. R. N. Thompson, with Miss Scott, Miss Snowball, Mr. Maden and Mr. Thirlwell ; Mr. N. S. Todd, with Miss Little and Mr. Chamberlain ; Mr. P. Forsyth Heppell, with Capt. Gibbs, Mr. N. Easey, Mr. Nicholson, Mr. H. Ellis, Mr. W. Baxter Ellis, with Mr. N. Easey, Mr. F. H. Phillips.

Passengers with Major Packman—Miss Betty Reed, Mrs. W. B. Harrison, Mr. Alderson.

On Wednesday, Sir Joseph Reed had instruction, under Major Packman, in cross-country flying, flying to Tamworth and back, the total flying time being six hours and a quarter.

Mr. R. Miesegaes was sent off solo on Tuesday, the 18th, putting up a splendid performance, and on Sunday Mr. C. Thompson made his first solo effort also in splendid style.

Mr. Ellis, Mr. Heppell and Major Packman flew the Gull on several occasions, the total time flown being two hours.

The Royal Air Force Memorial Fund.

THE usual meeting of the Grants Sub-Committee of the Fund was held at Iddesleigh House on May 20. Lieut.-Comdr. H. E. Perrin was in the Chair, and the other members of the Committee present were :—Mrs. L. M. K. Pratt-Barlow, O.B.E. ; Mr. W. S. Field ; Squadron-Leader E. B. Beauman.

The Committee considered in all fifteen cases, and made grants to the amount of £253 17s. 6d. The next meeting was fixed for June 3, at 2.30 p.m.

Gordon-Bennett Balloon Cup Race

SEVEN countries will be represented in the Gordon-Bennett Balloon Cup Race, which starts from Antwerp on May 30, as follows :—Great Britain, Belgium, France, Italy, Spain, Switzerland, and the United States.

Lantern Slides of Dynamometers

MESSRS. HEENAN & FROUDE, of Worcester, inform us they have prepared a series of lantern slides illustrating the " Froude " dynamometer and the " Heenan-Fell " air brake, together with reprint of a paper recently read before The Coventry Engineering Society by their Chief Engineer (Mr. G. H. Walker). They ask us to state that they will be pleased to place this material at the disposal of technical school and college engineers who may contemplate giving lectures and papers on the subject of testing prime movers for b.h.p.

Airship Production

MR. A. H. HALL, assistant superintendent of the Mechanical Engineering and Building Works Department of the Royal Ordnance Factories, has been transferred to the service of the Air Ministry on appointment by the Air Council to the post of Superintendent of Airship Production at Cardington.

Ross Kirkpatrick Killed

THE famous American pilot Ross Kirkpatrick, who flew from New York to Nome, Alaska, in 1920, met with a fatal accident on May 18, while making a forced landing in a U.S.A. Air Mail Service machine.

THE ROYAL AIR FORCE

London Gazette, May 11, 1926

General Duties Branch

The following Pilot Officers are promoted to rank of Flying Officer :—C. E. Galpin (Feb. 28) ; C. V. Williams (March 30) ; R. J. Stevens (April 15). The following Pilot Officers on probation are confirmed in rank :—G. Bradbury, R. C. H. Monk, E. G. L. Russell, A. W. Shaw (April 16).

The following are placed on half-pay, Scale B, from March 29 to March 31, inclusive :—Sqdn.-Leader R. C. Hardstaff ; Flight-Lieut. J. D. Breakey, D.F.C. Flying Officer H. J. Toye is transferred to Reserve, Class A (May 9) ; Pilot Officer M. E. de L. Hayes resigns his permanent commission (May 12) ; Flying Officer F. W. C. G. Tussaud relinquishes his short service commn. on account of ill-health (May 12).

Medical Branch

D. Oliver, B.A., is granted a short-service commn. as Flying Officer, for three years on active list, with effect from and with seniority of April 26, and is seconded for employment at Hull Royal Infirmary from that date; Flight-Lieut. D. McLaren, M.B., is promoted to rank of Sqdn.-Leader (May 4).

Memoranda

The permission granted to the following Lieutenants to retain rank is withdrawn on their enlistment in the Supplementary Reserve, Army :—S. Adams (April 19) ; D. G. Prentice (April 20).

Reserve of Air Force Officers

Pilot Officer M. E. de L. Hayes is granted a commn. in Class A, General Duties Branch, in this rank (May 12). The following Flying Officers relinquish their commns. on completion of service :—W. Anderson, C. Bunch, R. C. D'A. Gifford, F. W. Hartridge, A.F.C. (April 20) ; H. Haycock, M.C. (May 1) ; E. O'C. Parsons, W. Ridley, D.F.C. (May 8).

AUXILIARY AIR FORCE

General Duties Branch

The following to be Pilot Officer :—*No.* 601 (*County of London*) *Bombing Squadron.*—E. D. W. Reid, M.B. (May 11).

London Gazette, May 18, 1926

General Duties Branch

Flying Officer H. B. Williams is transferred to Reserve, Class A (May 3) Flying Officer J. H. Tanner (Lieut., R.A.) relinquishes his temp. commn. on return to Army duty (May 3).

Medical Branch

Flight-Lieut. J. Prendergast, M.B., B.A., is transferred to Reserve, Class D2 (May 15) ; Capt. P. E. Brown, Army Dental Corps, is granted a temp. commn. as a Flight-Lieut. on attachment to R.A.F. (May 1) (he will continue to receive emoluments from Army funds) ; Flight-Lieut. H. H. Mallett (Capt., Army Dental Corps) relinquishes his temp. commn. on return to Army duty (April 30).

Memorandum

Sec.-Lieut. C. F. Killelea relinquishes his hon. commn on enlistment in the T.A. (April 7).

Reserve of Air Force Officers

The following are granted commns. in the Gen. Duties Branch as Pilot Officers on probation :—*Class A.*—R. D. Hambrook (May 18). *Class AA.*—E. I. C. Wyllie (May 3) ; J. S. M. Michie (May 6).

Pilot Officer on probation H. W. Knott is confirmed in rank (May 10).

The following Flying Officers are transferred from Class A to Class C :—R. G. R. Godby (April 12) ; H. W. Beck (May 11). *Gazette* of Nov. 10, 1925, concerning Pilot Officer W. F. A. Snell is cancelled.

Princess Mary's R.A.F. Nursing Service

Miss K. I. Sweeny resigns her appointment as Staff Nurse (May 1).

ROYAL AIR FORCE INTELLIGENCE

Appointments.—The following appointments in the Royal Air Force are notified :—

General Duties Branch

Group Captain L. W. B. Rees, V.C., O.B.E., M.C., A.F.C., to H.Q. Transjordan, Supernumerary, pending taking over command, 6.5.26.

Squadron Leaders : J. C. Russell, D.S.O., to Air Ministry, Directorate of Organisation and Staff Duties, 1.5.26. J. Sowrey, A.F.C., H. Gordon-Dean, A.F.C., M. Henderson, D.S.O., A. W. F. Glenny, M.C., D.F.C., G. B. A. Baker, M.C., and H. K. Thorold, D.S.C., D.F.C., A.F.C., to R.A.F. Staff College, Andover, 9.5.26. J. J. Breen to R.A.F. Staff College, Andover, 1.5.26.

Flight Lieutenants : A. H. Wann, P. S. Jackson-Taylor, A. L. Fiddament, D.F.C., G. E. Gibbs, M.C., G. S. N. Johnston, R. M. C. Macfarlane, M.C., R. J. Divers, M.B.E., and A. C. Bayley, to R.A.F. Staff College, Andover, 9.5.26. J. H. Dand, M.B.E., to Sch. of Naval Co-operation, Lee-on-Solent, 14.5.26.

Flying Officers : A. H. D. Livock to R.A.F. Base, Calshot, 21.5.26. H. M. Whittle to R.A.F. Base, Calshot, 3.5.26. C. H. W. Boldero to Night Flying Flight, Biggin Hill, 24.5.26.

Pilot Officers : The undermentioned Pilot Officers are posted to No. 1 Flying Training Sch., Netheravon, on appointment to Short Service Commissions (on probation) with effect, 8.5.26. J. D. Allcroft, A. Allen, C. F. Ashton, E. S. Baverstock, S. C. Bell, E. L. Burslem, A. M. Butt, J. F. O'R. Coleman, M. R. Edmondes, L. E. R. Fisher, M.C., P. A. Hawkesworth, C. F. Hockley, A. M. D. Howes, G. H. G. S. Jenkins, W. E. P. Johnson, L. T. Keens, F. L. Lawrence, P. G. Lucas, L. G. Martin, A. L. Mortimer, K. C. Netherton, S. Pritchard-Barrett, H. J. G. E. Proud, B. F. O. Smith, R. H. C. Taylor, and E. D. Turner.

Stores Branch

Pilot Officer G. H. Doveton to Stores Depot, Iraq, 7.5.26.

NAVAL APPOINTMENT

The following appointment has been made by the Admiralty : Lieut. (Flying Officer, R.A.F.) A. M. Piling, to Columbine and for flying duties in No. 406 Flight (from date of joining).

IN PARLIAMENT

Imperial Airways and the Strike

Sir H. BRITTAIN, on May 20, asked the Secretary of State for Air the total number of miles flown by machines under Imperial Airways during the period of the strike, together with the number of passengers and the amount of freight carried ; and whether all passages were made without accident of any kind ?

Major Sir Philip Sassoon : The answer to the first part of the question is 41,500 miles, 944 passengers and 70 tons of freight, including goods, mails and passengers' luggage ; and, to the second, that no accident of any kind occurred.

R.A.F. Air Services and the Strike

Lieut.-Commander KENWORTHY asked the Secretary of State for Air how many miles were flown by aeroplanes in the Royal Air Force during the recent general strike ; whether any accidents took place ; and whether he can give an estimate of the weight of mails and goods and the number of passengers carried ?

Sir S. Hoare : The answer to the first part of the question is, approximately, 80,000 miles ; to the second, that two aircraft sustained damage in forced landings, the pilot of one being slightly injured ; to the third, that approximately 45 tons of mails and goods were carried and also some passengers, the exact number not being yet known.

Air Services and German Territory

Lieut.-Commander KENWORTHY asked the Secretary of State for Air what arrangements have been come to between the French and German Governments for the opening up of a number of air lines over German territory and permitting French commercial aeroplanes to fly over Germany ; what is the position with regard to British commercial aeroplanes flying over German territory ; and what is the position with regard to the proposed air line from London to Prague ?

Sir S. Hoare : As regards the first part of the question, an Air Traffic Agreement has been drawn up and agreed to by representatives of France and Germany, but, so far as I am aware, has not been signed and will not come into force until it has been formally ratified. As regards the remaining parts of the question, the position remains as stated in my reply of April 26, but negotiations for a British-German Air Traffic Agreement are now in progress.

Short Service R.A.F. Officers required for Flying Duties

THE Air Ministry announces :—Vacancies exist for short service officers in the General Duties Branch of the Royal Air Force for the courses of flying training commencing in July next, and applications are invited from candidates, who must be between 18 and 25 years of age, have received whole-time education at least up to the age of 16, and possess a sound physique and good eyesight. Short service commissions are granted for five years' service on the active list, followed by a period of four years on the Reserve. Selected candidates will be gazetted as pilot officers on probation and provided they make good and pass the tests laid down they are eligible for promotion to the rank of flying officer after 18 months' service.

The present rates of pay are 15*s.* 2*d.* a day for pilot officers, 18*s.* 10*d.* a day for flying officers under two years' service as such, and £1 1*s.* 8*d.* a day for flying officers after two years' service in the rank. When accommodation, fuel, light, rations and personal attendance are not available, allowances amounting to about 8*s.* a day ("unmarried" rates in home commands) are issuable in addition to pay. On transfer to the Reserve, on completion of five years' service on the active list, officers receive a gratuity of £375.

The number of short service officers who can be selected for permanent commissions is necessarily very limited, but under a recent decision short service officers, who have completed two years' service, are under 25 years of age, and are recommended, may take part in a competitive examination with a view to selection to undergo specialist training in aeronautical engineering, and to retention in the service on permanent commissions. Success in this examination will depend largely on mathematical and scientific attainments. Requests for forms of application and copies of the detailed regulations should be made in writing to the Secretary, Air Ministry, Adastral House, Kingsway, London, W.C.2.

AIR POST STAMPS

By DOUGLAS B. ARMSTRONG
(*Editor of " The Stamp Collector "*)

New Issues

WORLD-WIDE extension of the air post service is reflected in several new issues of aero stamps that have lately made their debut in countries as far apart as Egypt and Uruguay, U.S.A., and Germany. Soon the flying post will put a girdle round the earth.

The new 10 cents denomination which was added to the U.S. Air Mail series on February 13 comes in a distinctive oblong format to facilitate its ready recognition by postal sorters. Printed in deep blue, it typifies the trans-Continental air line with its outspread map of the Great Republic, and aeroplanes starting from New York and San Francisco. Actually it is employed solely in the Detroit-Chicago-Cleveland air mail zone, and for the present, at any rate, is only on sale in those cities and at Washington.

Egypt's long promised air post stamp finally materialised on March 10 in a striking design depicting an aeroplane flying over the Nile. It is a fine example of off-set printing, and reflects the highest credit upon the newly created Stamp Printing Department of the Survey of Egypt. Of the face value 27 milliemes, and deep violet in colour, it carries at the top the inscription " Royaume D'Egypte," whilst across the foot of the design are the words " Poste Aerienne." The watermark consists of the Royal cypher of King Fuad, repeated several times on each stamp. For the time being it is used exclusively in the Cairo-Baghdad air post service.

The latest German " Luftpost " stamps, issued on April 1, show an Eagle soaring over a mountain peak, and are surface printed in single colours for the pfennig values and bi-coloured for those in " marks," the series consisting of 5 pfg. green, 10 pfg. red, 20 pfg. blue, 50 pfg. orange, 1 mark rose and black, 2 marks blue and black, 3 marks olive-green and black.

Coincident with the resumption of the trans-Plate air post service between Montevideo and Buenos Aires last month, new stamps lettered " Correo Aereo " were put on sale by the Uruguayan post office in three denominations, viz., 6 cents, indigo ; 10 cents, red ; and 20 cents, blue-green. The subject of the Impressionistic design by J. A. Scasso, which is common to all three stamps, appears to be a Seagull hovering over a cultivated field. These stamps are lithographed in transverse rectangular form by the Imprensa Nacional upon paper watermarked " R.O. del Uruguay " in the sheet, and are supplied imperforate.

Forthcoming Aero Stamps

IN view of the proposed extension of the Italian air post service to Albania and adjacent countries, designs are being sought by the Air Ministry for a 5 lira stamp, to be added in due course to the existing air stamp series. South Africa is to have a new issue of air mail stamps bearing the device of a Junker aeroplane, when the contract air post service is put in operation between Capetown, Durban, and Johannesburg. Turkey, Jugo-Slavia, Hungary and Japan have all air post stamp issues in course of preparation, whilst a new issue for the Belgian Congo is anticipated. When the Albanian air service resumes operations this spring it is reported that the special stamps will be over-printed " Republika Shqiptere " in token of the change of government.

Canada's New Semi-Official Air Stamp

A QUASI-OFFICIAL stamp denoting the special air post fee of 25 cents was issued under authority of the Canadian Post Office Department on March 6, 1926, for use upon letters conveyed by the Jack V. Elliott Air Service, under contract, between Hudson (Ont.) and the Red Lake Mining District, via Rolling Portage. Printed in red and yellow at the office of the *Toronto Star* in small sheets of eight, ready gummed and perforated, the latest Canadian air post vignette is inscribed " Jack V. Elliott Air Service. First Red Lake Aerial Mail, 1926." Letters for transmission by this service must be endorsed " By Aerial Mail," and be properly prepaid as regards Canadian inland postage.

Mount Gambier-Melbourne Flight Reliques

SEVEN specimens only are believed to survive out of a small and hitherto unrecorded mail that was carried by the pilot Basil Watson on a survey flight from Mount Gambier to Melbourne on February 15 to 27, 1917, touching at Hamilton, Warranambool and Casterton *en route*. His mail consisted of official souvenir postcards of the type originally prepared for the Melbourne-Sydney flight of 1914, with a space for the town postmark in the lower left-hand corner. The stamp was cancelled on arrival at Melbourne with the oval " Australian Aerial Mail " cachet, dated Feb. 27, 1917.

SOCIETY OF MODEL AERONAUTICAL ENGINEERS (S.M.A.E.)

THE results of the two competitions, held at the Sudbury flying ground on Saturday, May 22, were as follows :—

Model Engineer No. 1 Cup
(For " Wing-only " type Models)

1st, D. A. Pavely.
2nd, S. C. Hersom.

Novices' Competition

1st, S. C. Hersom (junior).
2nd, R. B. Bucknell.

Members and others are asked to take note of the change of date of the speed competition, the rules of which were given in FLIGHT of March 25. This competition is to be held on Sunday, June 20, at 3 p.m. (instead of June 19), at the Royal Dental Hospital's sports ground (Hendon). This is situated on the south side of the Edgware Road, opposite Colindale Avenue—nearest station, Colindale, on the Hampstead Tube.

The Gamage Cup and Sir John Shelley Cup competitions are to be held at Wimbledon Common on Saturday, June 5.

Enquiries should be addressed to 58, Norton Road, Wembley.

B. K. JOHNSON, *Secretary*

R.A.F. Flying Accidents

THE Air Ministry regrets to announce that as the result of an accident at Andover, Hampshire, to a Fairey " Fawn " of No. 12 Squadron, Andover, on May 17, No. 84631, Sergeant Ralph England Hawkins, the pilot of the aircraft, and No. 335394, L.A.C. Sydney Marsh Cox, were killed.

As the result of an accident at Tents Muir, Leuchars, to a Fairey " Flycatcher " of the R.A.F. Training Base, Leuchars, on May 21, Peter Granville Smith, Lieutenant, Royal Navy, Flying Officer, Royal Air Force, the pilot and sole occupant of the aircraft, was severely injured and died later in the day.

Welding Rods

WE are notified that The British Oxygen Company have been appointed sole selling agents for their well-known brands of welding rods, namely, " Ferro-Silicon," " Super-Silicon " and " Sifbronze." The agency will include Great Britain, Northern Ireland, Irish Free State, India, Australia and New Zealand.

PUBLICATIONS RECEIVED

Aeronautical Research Committee Reports and Memoranda.—No. 987 (*Ae.* 199).—The Full Scale Determination of the Lateral Resistance Derivatives of a Bristol Fighter Aeroplane. By H. M. Garner and S. B. Gates. August, 1925. Price 1*s.* net.

No. 990 (*Ae.* 201.).—Full scale and Model Measurements of Lift and Drag of Bristol Fighter with R.A.F. 31 Wings. By B. D. Clark, R. G. Harris and L. E. Caygill. Sept. 1925. Price 6*d.* net. H.M. Stationery Office, Kingsway, London, W.C. 2.

The Overseas Airman, Vol. I., No. 3. *May,* 1926.—" The Overseas Airman," R.A.F. Depot., Aboukir, Egypt.

The Air Pilot Monthly Supplement. No. 19. *May,* 1926.—The Air Ministry, Kingsway, London, W.C.2.

FLIGHT

The Aircraft Engineer and Airships

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